

DOCUMENT RESUME

ED 219 260

SE 038 762

AUTHOR Greenstone, Sid; Smith, Murray
 TITLE Primary Astronomy.
 INSTITUTION Manitoba Dept. of Education, Winnipeg.
 PUB DATE Feb 81
 NOTE 74p.

EDRS PRICE MF01/PC03 Plus Postage.
 DESCRIPTORS *Astronomy; Elementary Education; *Elementary School Science; Foreign Countries; Resource Materials; *Science Activities; Science Curriculum; Science Education; Science Instruction; Teaching Guides; Units of Study
 IDENTIFIERS *Constellations; *Manitoba

ABSTRACT

Selected materials needed to teach an astronomy unit as well as suggested procedures, activities, ideas, and astronomy fact sheets published by the Manitoba Planetarium are provided. Subjects of the fact sheets include: publications and classroom picture sets available from the National Aeronautics and Space Administration and facts and statistics about the sun, moon, inner planets, outer planets, satellites of the solar system, planetary conjunction of 1981, meteors and meteor showers, comets, the Milky Way, quasars and pulsars, unidentified flying objects (UFO's), and activities of the Manitoba Planetarium. Instructions are provided for making constellation slides and constellation cans, with suggested student activities. Charts of constellations which may be duplicated or used to prepare overhead transparencies are also provided. Astronomy books and audio-visual materials available from the Manitoba Education Library and 16-mm films available from the School Film Services are included. (JN)

 * Reproductions supplied by EDRS are the best that can be made *
 * from the original document. *

ED219260

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

✓ This document has been reproduced as
received from the person or organization
originating it.

□ Minor changes have been made to improve
reproduction quality.

• Points of view or opinions stated in this docu-
ment do not necessarily represent official NIE
position or policy.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

John Tooth

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

MANIT^{BA}

DEPARTMENT OF EDUCATION
Program Development
Curriculum Services Branch
Telephone: 786-0317
Robert Fletcher Building
411 — 1181 Portage Avenue
Winnipeg, Manitoba
R3G 0T3

TO THE INSERVICE PARTICIPANTS:

The following booklet is presented to you in conjunction with a workshop on astronomy.

This booklet was designed as a hands-on approach to the field of astronomy. The focus is methodology coupled with essential theory. Our aim is to provide you with the materials you need to teach an astronomy unit to your students as well as suggested procedures, activities and ideas. Astronomy fact sheets have been gathered for you and are interwoven into each activity.

We hope that this inservice will be useful to you and to your students.

Thank you for your interest. If you have any questions and/or comments please, do not hesitate to contact us.

Yours truly,

Sid Greenstone
Sid Greenstone

Murray R. Smith
Murray R. Smith

PS: We can be contacted at the following places:

Sid Greenstone
c/o Faculty of Education
University of Manitoba
WINNIPEG, Manitoba
R3T 2N2
Phone: 1-474-9741

Murray R. Smith
Frontier School Division #48
121-1st Street S.W.
DAUPHIN, Manitoba
R7N 1M9
Phone: 1-638-6839

MANITOBA PLANETARIUM

Astronomical Information Sheet

NASA EDUCATIONAL PUBLICATIONS

The following is a partial list of Educational publications available from the National Aeronautics and Space Administration, Washington, D.C. These are ideal sources of pictures and resource material for school projects on space and space exploration. The publications should be ordered from:

Superintendent of Documents
U.S. Government Printing Office,
WASHINGTON, D.C. 20402

Payment may be made by cheque or money order payable in U.S. funds. Make sure to include the publication number in your order.

- EP-51 SPACE PHYSICS AND ASTRONOMY - A summary of progress in studies of Earth's radiation belts, the magnetic shell around the Earth, the solar wind, the Sun and Earth weather, meteorites, cosmic rays and the role of spacecraft as "robot star gazers". 22 pages/45¢.
- EP-52 NASA SPACECRAFT - The present family of NASA spacecraft. All types are discussed, some small, some large; some spin-oriented, some accurately attitude-controlled; some manned, some automated; some free in space until they expire, other commanded to return to Earth or to land on the Moon. 26 pages/50¢.
- EP-57 MAN IN SPACE - A chronicle of the Mercury, Gemini and Apollo Manned Space Flight Programs. 30 pages/85¢.
- EP-71 "IN THIS DECADE...." - Mission to the Moon - This "pre-launch" booklet outlines the complex steps leading to a manned lunar landing. The many and varied areas of research and development conducted by the National Aeronautics and Space Administration are illustrated. In colour. 48 pages/\$1.45.
- EP-72 LOG OF APOLLO 11 - The greatest voyage in the history of mankind, the journey of Apollo 11, is documented in this booklet. In colour. 12 pages/35¢.
- EP-84 SATELLITES AT WORK - Spacecraft for communications, geodesy and weather observations are described. The new area for working satellites of surveying of Earth resources is also covered. 23 pages/\$1.00.
- EP-94 APOLLO 15 at Hadley Base - The Lunar Voyage of Endeavour and Falcon is narrated with full colour illustrations and a traverse map. 32 pages/\$1.35.

- EP-91 APOLLO 14: SCIENCE AT FRA MAURO - Exploration of the upland Fra Mauro area of the moon incorporated the most extensive scientific observations in manned lunar exploration up to that time. The story is presented in text, a traverse map and spectacular colour photographs. 48 pages/\$1.25.
- EP-06 SPACE SHUTTLE - This publication describes the space shuttle program and augments the material on wall poster. NF-44. /70¢.
- EP-97 APOLLO 16 AT DESCARTES - A comprehensive look at the flight of Apollo 16, covering the highlights of the mission, including many detailed colour photographs. /\$1.35.
- EP-100 APOLLO - Commemorative Book summarizes the historic manned lunar landing program and features in colour some of the best photographs from each Apollo mission. 64 pages/\$2.65.
- EP-118 OUR PRODIGAL SUN - The dynamic Sun, its characteristics observed and measured by spacecraft, is proving more complex and fascinating than ever; especially for a world anxious to use its store of energy. 14 pages/35¢.
- EP-120 QUASARS, PULSARS, BLACK HOLES AND HEAVY STARS - Astrophysics, the physics of the stars, takes on exciting new dimensions as the result of recent discoveries in the visible high-energy universe where physical processes are so powerful they cannot be reproduced on Earth. 24 pages/80¢.
- EP-121 NASA AND ENERGY - NASA is developing ways to tap the heat and light of the Sun to meet the nation's future energy requirements. But that is only part of the story. NASA engineers also are working on clean, renewable fuels; wind-generated electricity; finding new fuel deposits; and exploring a variety of conservation techniques. 16 pages/35¢.
- EP-32 LEARNING ABOUT SPACE CAREERS - Provides upper elementary students with ideas and suggestions for things to do to help with a career choice. It includes information about the space industry and the world of work. 24 pages/25¢.

The following are publications in the NASA FACTS Series. They contain condensed information on a NASA Program or a related area of research. Some are in the form of wall posters.

- NF-27 LIVING IN SPACE - A description of the life support system devised by science and industry to enable spacecraft crews to remain in space for extended periods of time in an Earth-like environment. 12 pages/30¢.
- NF-33 SATURN V - Colour wall poster depicting Saturn V, America's largest rocket vehicle, which launches the Apollo spacecraft. /25¢.

- NF-40 JOURNEY TO THE MOON - A colour wall poster depicting manned space flight to the Moon, including landing on the Moon, re-joining the Apollo spacecraft, and the return to Earth. /60¢.
- NF-43 SKYLAB - A colour wall poster describing in words and pictures NASA's first earth-orbiting space station - SKYLAB. /60¢.
- NF-44 SPACE SHUTTLE - A colour wall poster similar to NF-43, but in this case illustrates NASA's reusable space vehicle, the SPACE SHUTTLE. /60¢.
- S-2 SPACECRAFT TRACKING AND COMMUNICATION - Jr. High School - General Science - A Simplified description of the electronics communication bridges between Earth-based controllers and mission-performing manned and unmanned space-craft. /5¢.
- S-4 THE COUNTDOWN - Elementary: General Science - Describes the activities and preparations that take place before, during and after the launching of a spacecraft. /5¢.
- S-5 WEIGHTLESSNESS - Jr. High School: Physics - Weightlessness is explained by everyday experiences and simple experiments in this description of a complex phenomenon. /5¢.
- S-6 SOLAR CELLS - High School: Physical Science - An explanation of the primary source of electrical power for the majority of NASA's unmanned space missions. /5¢.
- S-7 ORBITS AND REVOLUTIONS - High School: Physics - A description of the physical and mathematical principles that govern the movement of one body about another in the environment of space. /10¢.

CLASSROOM PICTURE SETS

- NASA PICTURE SET #1 - APOLLO - "IN THE BEGINNING...." - Seven 11" x 14" colour lithographs that illustrate highlights from the Apollo 8, 9, and 10 missions. /\$1.85 per set.
- NASA PICTURE SET #2 - MEN OF APOLLO - Five 11" x 14" colour lithographs that include portraits of the crews of Apollo, 7, 8, 9, 10 and 11. /\$1.00 per set.
- NASA PICTURE SET #5 - MAN ON THE MOON - One 16" x 20" colour lithograph that best illustrates man's moments of success, the first step in his conquest of space. /\$1.00 per copy.
- NASA PICTURE SET #6 - APOLLO 12 - Pinpoint landing on the Moon. Eight 11" x 14" colour lithographs and two 11" x 14" black and white lithographs illustrating man's return to the Moon. /\$2.00 per set.
- NASA PICTURE SET #7 - APOLLO 15 - Nine 11" x 14" colour lithographs illustrating the journey to the Moon of Endeavour and Falcun. /\$2.10 per set.

MANITOBA PLANETARIUM
Astronomical Information Sheet
"A STAR CALLED SUN"

Our sun is one of a hundred billion stars that make up the giant whirlpool island universe we call the Milky Way Galaxy. It has been in existence for approximately five billion years and may last another five billion. We must consider this brilliant yellow orb in our day-time sky as a tremendous hydrogen bomb, the energy being produced as a result of a fusion process whereby hydrogen, the lightest known element is converted into helium. The sun slowly is evolving into a brighter, hotter star at present, but astronomers are uncertain as to eventual fate: will it continually expand into oblivion? By that time there will surely be no possibility of life on earth, for it will have grown extremely cold--or hot.

SOME FACTS ABOUT THE SUN

Layers	Corona, Chromosphere, Photosphere, core
Mean Distance From Earth	149,600,000 km.
Maximum Distance From Earth	152,083,000 km.
Minimum Distance From Earth	147,260,000 km.
Mass	333,400 Earth masses, or 2.0×10^{27} metric tons
Spectral Type	G2V
Diameter (Photosphere)	109.3 Earth diameters, 139,112 km.
Velocity with respect to the nearby stars	20 km/sec.
Mean Density	1.41 gm/cc
Gravity (at photosphere)	27.9 times that of earth
Visual Magnitude	-26.5
Rotation Period at Equator	24 days, 16 hours
Rotation Period at Poles	Approx. 35 days
Inclination of Pole to Ecliptic	7 degrees 10.5 minutes
Temperature of Photosphere	6000°C
Temperature of Core	14,000,000°C
Average Time Between Minimum and Maximum Numbers of Sunspots	11.1 years (extremes, 7-17 years)
Size of Sunspots	3,000 - 150,000 km; average size approx. 15,000 km.

MANITOBA PLANETARIUM

Astronomical Information Sheet STATISTICS OF THE INNER PLANETS

	<u>Mercury</u>	<u>Venus</u>	<u>Earth</u>	<u>Mars</u>
Equatorial Diameter	4,865 km.	12,110 km.	12,756 km.	6,788
Closest Approach to Sun	45,992,200 km.	107,449,700 km.	147,070,400 km.	206,553,600 km.
Farthest Distance from Sun	69,803,500 km.	108,915,500 km.	152,065,900 km.	249,180,500 km.
Period of Revolution	88.0 ^d	224.7 ^d	365.26 ^d	687.0 ^d
Period of Rotation	58 ^d 16 ^h	243 ^d (Retro)	23 ^h 56 ^m 04 ^s	24 ^h 37 ^m 23 ^s
Length of Day	175 ^d 20 ^h 24 ^m	117 ^d 01 ^h 09 ^m	24 ^h 00 ^m 00 ^s *	24 ^h 39 ^m 25
Inclination of Orbit to Ecliptic Plane	7°	3.4°	0.0° *	1.8°
Inclination of Axis to Plane of Orbit	7° or less	174°	23.4°	24.0°
Mass (Earth = 1)	0.055	0.815	1.000 *	0.107
Density (Water = 1)	5.46	5.23	5.52	3.93
Surface Gravity (Earth = 1)	0.38	0.90	1.00 *	0.38
Composition of Atmosphere	Ionized atomic particles	Carbon dioxide, Ice Crystals	Oxygen, Nitrogen, water vapor	Carbon dioxide, Oxides of nitrogen
Temperature Range at Equator **	290°/700°K.	700° K. (?)	265°/330° K.	200°/290° K.
Albedo (% of Sunlight Reflected by Planet)	5.6%	76%	36%	16%
Synodic Period	116 ^d	584 ^d	—	780 ^d
Number of Satellites	0	0	1	2

*By Definition **T° K. = (T + 273)° C.

MANITOBA MUSEUM OF MAN AND NATURE - PLANETARIUM
Astronomical Information Sheet

THE EARTH - OUR SPACE SHIP

Equatorial Diameter:	12,756 kilometers/7,927 miles
Polar Diameter:	12,714 kilometers/7,900 miles
Amount of Polar Flattening:	1/298.25 or 0.003353
Mass:	5.98×10^{21} metric tons
Mean Density:	5.52 grams/cubic centimeter (Water = 1,000)
Surface Gravity:	1.00 by definition (Jupiter = 2.64, Moon = 0.16).
Escape Velocity:	11.2 kilometers/second or 6.94 miles/ second
Inclination of Equator to Plane of Orbit around Sun:	23.4 degrees
Mean Distance from Sun	149,600,000 kilometers/92,957,000 miles
Minimum Distance (Perihellon):	147,070,400 kilometers/91,404,800 miles
Maximum Distance (Aphelion):	152,065,900 kilometers/94,509,600 miles
Mean Orbital Velocity:	29.8 kilometers/second or 18.5 miles/ second
Velocity of Escape from Solar System at Earth's Distance from Sun:	42.3 kilometers/second or 26.2 miles/ second.
Length of Sidereal Day:	23 ^h 56 ^m 04 ^s of mean solar time, relative to the fixed stars
Length of Solar Day:	24 ^h 00 ^m 00 ^s by definition. 24 ^h 03 ^m 57 ^s of sidereal time
Length of Sidereal Month:	27 ^d 07 ^h 43 ^m 12 ^s relative to the fixed stars
Length of Synodic Month:	29 ^d 12 ^h 44 ^m 03 ^s new moon to new moon
Length of Sidereal Year:	365 ^d 06 ^h 09 ^m 10 ^s relative to the fixed stars.
Length of Tropical Year:	365 ^d 05 ^h 48 ^m 46 ^s vernal equinox to vernal equinox
Temperature Range at Equator:	265/330 degrees Kelvin or +20/+135 degrees Fahrenheit
Albedo (% of Reflected Sunlight):	36%
Composition of Atmosphere:	Oxygen, Nitrogen, Water vapor
Earth's Motion as a Member of the Solar System:	
1. Sun's Local Motion - Direction:	Toward the constellation Hercules
- Velocity:	19.4 kilometers/second or 12.1 miles/ second
2. Sun's Revolution in our Galaxy:	
Distance to Centre:	30,000 light years/10,000 parsecs
Period of Revolution:	2.2 million years
Orbital Velocity:	260 kilometers/second or 160 miles/second

MANITOBA MUSEUM OF MAN AND NATURE - PLANETARIUM
Astronomical Information Sheet

THE MOON - OUR NEAREST NEIGHBOUR IN SPACE

In 1969, the moon became the first astronomical body to be visited by man. Many theories about the origin and nature of the moon were put to rest as a result of this and of subsequent visits through the end of 1972. The lunar rock samples and the data sent back by instruments deployed on the moon by the astronauts will continue to provide, for decades to come, information of the nature of the moon and on the origin of the solar system.

Mean Distance from Earth:	384,344 Kilometers/238,865 miles
Minimum Distance (Perigee):	356,334 Kilometers/221,463 miles
Maximum Distance (Apogee):	406,625 Kilometers/252,719 miles
Sidereal Period of Revolution:	27 ^d 07 ^h 43 ^m 12 ^s relative to the fixed stars.
Synodic Period of Revolution:	29 ^d 12 ^h 44 ^m 03 ^s new moon to new moon
Periods of Rotation:	Same as periods of revolution
Stellar Magnitude:	-12.7 at full moon (This is 40,000 times the brightness of a first-magnitude star).
Equatorial Diameter:	0.273 earth diameters/3,476 km./2,160 ml.
Degree of Polar Flattening:	Nil
Mass:	0.0123 earth masses/6.57 x 10 ¹⁹ metric tons
Average Density:	3.36 grams/cubic centimeter (water = 1,000)
Surface Gravity:	0.165 earth gravity (eg. 150 lb. weighs 25 lb)
Escape Velocity:	2.2 kilometers/second or 1.5 miles/sec.
Atmospheric Composition:	Nil
Temperature - Sunlit Side:	382° Kelvin/+230° Fahrenheit*
Temperature - Dark Side:	94° Kelvin/-289° Fahrenheit*
Albedo (1% of reflected sunlight):	8.6%
Inclination of Equator to Orbit:	6.7 degrees
Inclination of Equator to Plane of Solar System:	Variable: 18 to 29 degrees
Inclination of Orbit to Plane of Solar System:	5.15 degrees
Eccentricity of Orbit:	0.0549

*T° Kelvin = (T = 273)° Celsius

MANITOBA PLANETARIUM
Astronomical Information Sheet
STATISTICS OF THE OUTER PLANETS

	<u>Jupiter</u>	<u>Saturn</u>	<u>Uranus</u>	<u>Neptune</u>	<u>Pluto</u>
Equatorial Diameter	142,749+	120,862+	46,993+	44,579+	5,600-12,900+
Closest Approach to Sun	740,670,224+	542,925,926+	2,734,690,313+	4,458,083,758+	4,423,742,739+
Furthest Distance from Sun	816,068,698+	1,506,473,283+	3,005,466,545+	4,535,875,842+	7,376,680,569+
Period of Rotation	9 ^h 50 ^m 30 ^s	10 ^h 14 ^m	10 ^h 49 ^m (Retro)	14 hours	6 ^d 9 ^h 16 ^m
Length of Day	"	"	From 10 ^h 49 ^m to 42 years	"	"
Period of Revolution	11.86 yrs.	29.46 yrs.	84.01 yrs.	164.8 yrs.	247.7 yrs.
Inclination of Orbit	1.3°	2.5°	0.8°	1.8°	17.2°
No. of Satellites	13 or 14	10	5	2	1
Mass (Earth=1)	318.0	95.2	14.6	17.3	0.05
Density (Water=1)	1.33	0.69	1.56	2.27	4
Surface Gravity (Earth=1)	2.64	1.13	1.07	1.41	0.3
Composition of Atmosphere	Hydrogen Helium Neon Methane and Ammonia	Hydrogen Helium Neon Methane and Ammonia	Hydrogen Helium Methane	Hydrogen Helium Methane	Undetectable
Temperature Range at Equator	-157°	-171°C	-184°C	-198°C	-212°C
Albedo (% of sun-light reflected)	73%	76%	93%	84%	14%
Synodic Period	399 ^d	378 ^d	370 ^d	367 ^d	367 ^d
Inclination of Axis	3°	27°	98°	29 1/2°	?

Distances in Kilometers +

MANITOBA PLANETARIUM
Astronomical Information
SATELLITES OF THE SOLAR SYSTEM

<u>Designation</u>		<u>Diameter</u>	<u>Distance from Planet</u>	<u>Period</u>	<u>Discovery</u>
		km	km	d h m	
Earth 1	Moon	3,476	384,000	27 07 43	-----
Mars 1	Phobos	23*	9,000	00 07 39	1877, Hall
Mars 2	Deimos	13*	23,000	01 06 18	1877, Hall
Jupiter 5	Amalthea	(160)	180,000	00 11 57	1892, Barnard
Jupiter 1	Io	3,660*	422,000	01 18 28	1610, Galileo
Jupiter 2	Europa	2,880	671,000	03 13 14	1610, Galileo
Jupiter 3	Ganymede	5,460*	1,070,000	07 03 43	1610, Galileo
Jupiter 4	Callisto	4,460	1,884,000	16 16 32	1610, Galileo
Jupiter 13	Leda	(5)*	10,200,000*	210 15 --*	1974, Kowal
Jupiter 6	Himalia	(100)	11,477,000	250 14 --	1904, Perrine
Jupiter 7	Elara	(40)	11,738,000	259 16 --	1905, Perrine
Jupiter 10	Lysithea	(15)	11,857,000	263 13 --	1938, Nicholson
Jupiter 12	Ananke	(15)	21,240,000	631 02 --R	1951, Nicholson
Jupiter 11	Carne	(15)	22,530,000	692 12 --R	1938, Nicholson
Jupiter 8	Pasiphae	(15)	23,500,000	738 22 --R	1908, Melotte
Jupiter 9	Sinope	(15)	23,700,000	758 -- --R	1914, Nicholson
Saturn 10	Janus	(350)	160,000	00 17 59	1966, Dollfus
Saturn 7	Mimas	(900)	187,000	00 22 37	1789, Herschel
Saturn 8	Enceladus	550	238,000	01 08 53	1789, Herschel
Saturn 5	Tethys	1,200	295,000	01 21 18	1684, Cassini
Saturn 6	Dione	800	378,000	02 17 41	1684, Cassini
Saturn 4	Rhea	1,300	526,000	04 12 25	1672, Cassini
Saturn 1	Titan	5,800*	1,221,000	15 22 41	1655, Huychens
Saturn 2	Hyperion	(320)	1,480,000	21 06 38	1848, Bond
Saturn 3	Iapetus	(1,150)	3,561,000	79 07 56	1671, Cassini
Saturn 9	Phoebe	(260)	12,960,000	550 11 --R	1898, Pickering
Uranus 5	Miranda	(550)	124,000	01 09 56	1948, Kuiper
Uranus 3	Ariel	(1,450)	191,000	02 12 29	1851, Lassell
Uranus 4	Umbriel	(970)	267,000	04 03 38	1851, Lassell
Uranus 1	Titania	(1,800)	438,000	08 16 56	1787, Herschel
Uranus 2	Oberon	(1,600)	587,000	13 11 07	1787, Herschel
Neptune 1	Triton	3,800	354,000	05 21 03R	1846, Lassell
Neptune 2	Mereid	(530)	5,570,000	359 10 --	1949, Kuiper
Pluto 1	1978 P1	Provisional	20,000	06 09 17	1978, Christy

MERCURY and VENUS have no known satellites.

*-Recent Value ()=Uncertain Value R=Retrograde Orbit

Io, Europa, Ganymede and Callisto were discovered by Galileo with a crude telescope, and they can be seen in an ordinary pair of 6 or 7 power binoculars.

Charles Kowal at Cal. Tech. has detected an object that may be a 14th moon of Jupiter.

THE GREAT PLANETARY CONJUNCTION OF 1981

The Great conjunction of 1981 is unusual because Jupiter and Saturn appear to pass each other three times this year, between January and the end of July. The earth must be in exactly the right position in space for us to see a triple Jupiter/Saturn approach. The event is a rare one. The last similar triple conjunction occurred in 1940-41, and the next will not happen for 258 years.

As the planets orbit the Sun, from our viewpoint on Earth, they occasionally appear to move very close together. When they appear closest together they are said to be in conjunction. Of course, the planets never really get close in space. At present Jupiter is 700 million kilometers from Earth. Saturn is in the same direction as Jupiter, as seen from the Earth, but it is nearly twice as far away at a distance of 1.3 billion kilometers.

As Jupiter and Saturn move around the sky, Jupiter overtakes Saturn and the planets come into conjunction about every 19 years. The planets seldom come so close together that they appear as one star. Usually they pass within a degree or two of each other. For reference, the Moon appears $1/2$ degree in diameter.

This is the last conjunction of Jupiter and Saturn that will be visible until December 21, 2020. The conjunction of May 28, 2000, will be so close to the Sun that it will be invisible in the Sun's glare. The 1981 triple conjunction is the eleventh since 7 BC. The 7 BC conjunction, according to some scholars, set the Wise Men on their journey to Bethlehem, and provided the origin for the Planetarium's story of the Christmas Star.

The following is a timetable of events to watch for in 1981:

Wednesday, January 14	First Conjunction - Jupiter and Saturn 1.1 degrees apart. (The Moon is $1/2$ degree across).
Sunday, January 25	Moon within 2 or 3 degrees of Jupiter and Saturn. This will be a very pretty sight between 11 p.m. and dawn.
Thursday, February 19	Second Conjunction. Jupiter and Saturn, after moving apart slightly are again close, only 1.1 degrees apart.
Saturday, February 21	Moon again close to Jupiter and Saturn.

THE GREAT PLANETARY CONJUNCTION OF 1981 cont'd.

Thursday, July 30

Third Conjunction. Jupiter 1.2 degrees from Saturn. In the winter and spring these planets were seen in the late night and morning sky. Now they are in the southwest early in the evening.

July 25 to July 28

Venus moves past Jupiter and Saturn coming within 2 degrees of Jupiter and 0.9 degrees of Saturn. These three planets will, by the end of July be very low in the southwest at sunset.

Between the first and second conjunctions, the separation between the planets increases only from 1.1 degrees to about 1 1/4 degrees. Since Jupiter and Saturn are moving near a faint star, Eta, in the constellation Virgo, it is easy to note even the minute day to day changes in their positions.

Between the second and third conjunctions the planets will separate until they are nearly 3 degrees apart in mid-May. Between August 24 and Sept. 1, Jupiter, Saturn, Venus, the Moon and the bright star Spica will form a series of configurations in the southwestern sky in the evening. These will be fascinating to watch as they change their positions day to day.

A pair of binoculars, if focused carefully and braced against a fence post or a door frame will give an interesting view of the Moon and Planets. (Do not look through a window as it will make the image fuzzy). Binoculars won't quite show the rings of Saturn, but they will show the craters on the Moon and four of Jupiter's Moons.

for further information:

Bill Peters or

Kathy Roos Pavlik

956-2830 ext. 127 or 147

MANITOBA PLANETARIUM
Astronomical Information
METEORS AND METEOR SHOWERS

The earth is constantly bombarded by large and small particles from outer space. Since the earth travels through space at a velocity of almost 108,000 kilometers per hour, it often collides with particles in space which are heated up as they enter the atmosphere. Most of the smaller pieces burn up before they reach the ground. Some of the larger ones that do reach the ground are recovered. These are called meteorites. Meteorites fall into three classes; stony (aerolites), irons (siderites) and stony-irons (siderolites). Stony meteors often break up at the end of their flight. Meteors whose trains are coloured are likely to be metallic in composition.

DEFINITIONS: The particle, when it is still in space, is called a meteoroid; the luminous phenomenon caused when the particle enters the earth's atmosphere is a meteor; and if it survives and lands on the ground, the particle is a meteorite. No known meteorite is of shoer origin.

SOME FACTS ABOUT METEORS

Velocity of Observed Meteors	144,000 km./hr	15-75 km/sec.
Average Rate of Visible meteors for a single observer (not during shower)	10 per hour	
Rate of a Shower	15 - 50 per hour	
Daily Mass of Material Reaching Earth	50 - 100 Metric Tons	
Meteor Surface Temperature at Maximum	300°K	
Height of Appearance of Meteors	Sporadic 100 km.	Shower 115 km.
Largest known Meteorite	9 cubic meters (found in South Africa)	

MANITOBA PLANETARIUM

Astronomical Information

COMETS

Comets are strange space wanderers, once regarded as from outer space, but now regarded as being part of our solar system, some of the stuff left over when the planets formed. This leftover material orbits the sun outside Pluto, and occasionally some condensations of it form and begin to travel in altered paths that bring them within our observation. As they approach the sun they begin to glow as the frozen material of the comet is turned to gas and excited by the sun's radiation.

Four names are given to observable parts of a comet. The head is called the coma and may show two characteristics; an indistinct central condensation and a much smaller bright fuzzy spot called the nucleus. Extending away from the coma is the characteristic tail of the comet. The tail is formed by gases and small particles driven out of the coma by the solar wind and radiation pressure of the sun. The tail may fork, the lighter gas molecules being driven in straight lines away from the sun by radiation, and heavier dust particles curving away affected both by solar wind and gravitation.

Periodic comets are those known to reappear at more or less regular intervals. All comets are now regarded as probably periodic unless perturbed so that they escape from the solar system.

SOME FACTS ABOUT COMETS

Average period of a periodic comet	Approx. 7 years (most of the bright ones are longer than this)
Average <u>perihelion</u> distance (closest approach to the sun)	153,000,000 km.
*Average magnitude	9.5
<u>Rate of Discovery of Comets</u>	
New Indefinite Period	3 per year
New Periodic	1 per year
Periodic (predicted and observed on a subsequent passage)	2.5 per year
Comets visible to the naked eye	2 per year
Average number of appearances before breaking up	7
*Diameter of coma	Approx. 274,000 km.
Diameter of central condensation	Approx. 2,700 km.
Diameter of nucleus	Approx. 13 km.
Length of tail visible to the eye	from 9,650,000 km. to 200,000,000 km. in special cases

Solar distance at which tail appears	Approx. 240,000,000 km.
Atoms & molecules observed in comet heads	Water, Sodium, Carbon, Cyanide, Methane, Ammonia
Atoms & molecules observed in comet tails	Cyanide, Nitrogen, Carbon Dioxide

*These characteristics change with solar distance and thus are given here for the perihelion distance.

MANITOBA PLANETARIUM
Astronomical Information Sheet
THE MILKY WAY

Our sun is located approximately two thirds of the way out from the centre of a huge aggregation of stars that is shaped like an enormous pinwheel. The pinwheel is slightly thicker at the centre than at its edge, and is called the Milky Way Galaxy. Distances in our Galaxy are so great that it is impractical to use our familiar yardsticks such as centimeter, meters and kilometers to measure them. The measurement that astronomers often use is called the light-year, and it is the distance that light can travel (at 300,000 km. per second) in the course of one year. However, for reasons of convenience, astronomers more often use the parsec to measure distances. The parsec is equal to 3.26 light years, and thus contains about 30,850,000,000,000 kilometers!

Astronomers find that our sun and the rest of the stars in the galaxy are moving with respect to each other as our galaxy rotates. Although this movement is quite rapid, the distances involved are so great that we could not notice the change in position of any of the stars until tens of thousands of years had passed!

We also know that the galaxy contains, besides individual stars, gas clouds (called nebulae) and special groups of stars called clusters. These are all rotating around the centre of the galaxy with all the rest of the stars.

SOME FACTS ABOUT THE GALAXY

Diameter	25,000 parsecs (pc.)
Thickness at the centre	4,000 pc.
Thickness at the sun's location	300 pc.
Distance between spiral arms	1,400 pc.
Thickness of spiral arms	600 pc.
Mass	1.1×10^{11} solar masses
Period of Rotation of the Sun around the Galaxy	200,000,000 years
Velocity of the sun's motion in the Galaxy	774,000 km. per hour

MANITOBA PLANETARIUM
Astronomical Information Sheet
QUASARS AND PULSARS

Quasars are possibly the most puzzling astronomical objects yet discovered. Although we have known about them since 1960, astronomers have not yet been able to explain them. They were first noted as being very small sources of powerful radio waves. Optical telescopes revealed them as objects that looked like stars. However, our spectroscopes show us that they are travelling away from us with enormous velocity, greater than that of any object in space that we have observed so far.

Astronomers believe that the very high velocity of quasars is due to the expansion of the universe. This would mean that they are the most distant objects ever observed, with distances up to 9 billion light years! However, they seem much too bright to be so far away. If they really were at that distance they would have to be as bright as one hundred thousand million of our suns! Astronomers are still not sure if it is even possible for an object to be that bright!

We also find that the light from these objects is variable. The laws of physics tell us that an object which varies as rapidly as quasars do, must be quite small. However, if they are as bright as mentioned above they certainly cannot be that small.

Unfortunately, we find that as our observations of these objects increase, we find no answers, only more questions. Some astronomers believe that quasars are early stages in the formation of a galaxy. Others feel that they might not even be all that far away, but then it is difficult to explain the high velocity.

It is very likely that the puzzle of the quasars will remain unsolved for quite a number of years.

Pulsars, on the other hand, were very quickly explained after being discovered. The first one was observed in 1967 by astronomers at Cambridge University using a radio telescope. They found that the pulsar emitted radio pulses about once every second. The remarkable feature of these pulses was their regularity. They would repeat with an accuracy of much less than one one-millionth of a second. For a short time it was believed that they might be signals from some intelligent civilization on another world. However, soon many more were discovered and this theory was discounted.

It was not long before pulsars were identified with faint stars that appeared to be quite unusual in nature. These were believed to be neutron stars; the final product of the cataclysmic explosion of a very old star. This explosion is called a supernova. The neutron star theory was proven to be correct when a pulsar was discovered in the Crab Nebula, the known remains of such an explosion.

These neutron stars are rotating extremely rapidly and have strong magnetic fields. The combination of these two characteristics gives rise to the rapid radio pulses.

Although astronomers have now solved the mystery of pulsars, they are still very much interested in them. They can tell us a great deal about the life cycle of stars, and their radio pulses can be used to perform other experiments in space to test theories like relativity, for example, or to study the nature of invisible material in outer space.

RESOURCES LIST

MANITOBA PLANETARIUM 956-2830
ROGER WOLOSHYN (EDUCATION) ext. 125
BILL PETERS (TELESCOPES) ext. 127
ROBERT BALLANTYNE (GEN) ext. 128
ED BARKER (UFO'S) ext. 113

UNIVERSITY OF MANITOBA
DR. RICHARD BOCHONKO 474-9501
LOCKHART PLANETARIUM 474-9785

UNIVERSITY OF WINNIPEG
DR. DON KERR 786-7811

RASC WINNIPEG CHAPTER
HANS THATER 669-6213
2nd Friday of each month 217 Lockhart Hall, University of
Winnipeg

DEPARTMENT OF EDUCATION
SCHOOL FILM SERVICES 786-0222

EDUCATIONAL MEDIA DIVISION
DEPARTMENT OF EXTENTION
UNIVERSITY OF ALBERTA
82nd Avenue & 112th Street
Edmonton, Alberta
T6G 2E1 (403) 432-5041

- UNIVERSE
- APOLLO 16: NOTHING SO HIDDEN
- APOLLO 17: ON THE SHOULDERS OF GIANTS

SPACE STUDIES INSTITUTE
P. O. BOX 82
PRINCETON, NEW JERSEY
USA. 08540 \$10/year donation for information

NASA
WASHINGTON, DC. 20546
ASTRONOMY \$18/year
411 E. MASON STREET
P.O. BOX 92788
MILWAUKEE, WI
USA. 53202

JPL
4800 OAK GROVE DRIVE
PASADENA, CALIFORNIA
USA. 91103
SKY AND TELESCOPE \$17.50/yr.
SKY PUBLISHING CORPORATION
49 BAY STATE ROAD
CAMBRIDGE, MASS.
USA. 02238

MANITOBA PLANETARIUM

Astronomical Information Sheet

The Manitoba Planetarium is a multi-purpose audio visual theatre dedicated to providing the best in Astronomical and Entertainment programming for Manitobans and visitors. The Planetarium project was inspired by Canada's Centennial in 1967 and its construction was, in part, made possible through the generosity of the family of Saidye and Samuel Bronfman. Since the Manitoba Planetarium opened on May 15th, 1968 it has attained a significant place in the international Planetarium community. In addition, it has hosted light shows, religious services and artistic performances.

THE STAR THEATRE

The Planetarium's dome is the biggest projection screen in Manitoba. Literally hundreds of projectors work together to fill it with imagery. One hundred and fifty four separate projectors are clustered on the Zeiss Planetarium Projector in the centre of the room. These projectors work together to show nearly 9,000 stars - all that the unaided eye can see - as well as the Sun, Moon and Planets. The Zeiss Instrument gears these projectors together so accurately that they can be used to show the sky as our ancestors saw it thousands of years ago, or as Earthlings will see it far in the future.

When the Carl Zeiss Optical Company of Oberkochen, West Germany produced this projector in 1966 it sold for \$200,000. The current cost of a similar projector is in excess of \$1 million.

The Planetarium Design and Engineering staff has created the many special effects projectors that are hidden in the projection gallery, running all around the bottom edge of the dome. These projectors can produce an awe inspiring sunset, the landscape on distant world, the strange views seen by an interstellar traveller, or even a death defying plunge through a Black Hole. All of the projectors are run by a very busy operator from the control console in the Star Theatre.

PLANETARIUM SHOWS

Most Astronomical shows are written and produced right at the Manitoba Planetarium. Occasionally an outstanding production, created at another Planetarium, is presented in the star theatre. Scripting, artwork, and recording are done by the Planetarium's Director, Producers and Artist/Photographer. Narrators, actors, actresses and film-makers of local and national stature add their talents to the creation of the feature presentations.

Over a dozen exciting programs are presented every year for students from kindergarten through high school. These shows touch all aspects of astronomy, from the intriguing sky lore of the ancient Greeks to the mysterious Quasars at the edge of the visible Universe.

PLANETARIUM INFORMATION

To see a feature presentation call 943-3142 for show times and information. Information and bookings for our complete range of School Programs is available at 943-3204. Group visits and special events can be arranged by calling the Planetarium offices at 956-2830. When planning a visit be sure to leave time to tour the Hall of Astronomy, a 7,500 sq. foot exhibit gallery that takes a colourful look at star-gazing from ancient times through the revelations modern telescopes and spaceflight. In the gallery the Copernicus Solar Telescope projects an impressive, detailed, 52 inch diameter image of the Sun, every clear day.

THE SKY SHOW

For a brief, fun course in skywatching to really start appreciating the wonders of a dark evening sky, don't miss "The Sky Show". This special performance is presented live on the second Sunday of each month at 5:00 pm. and it includes a free star map.

MANITOBA PLANETARIUM
and
MANITOBA CENTRE FOR U.F.O. STUDIES
UNIDENTIFIED FLYING OBJECTS

I. What is a U.F.O.?

An Unidentified Flying Object is exactly what it's name implies. It is something that seems to travel through the air or even to land, but we cannot explain what it is.

More than 90% of all the Unidentified Flying Objects that are reported, can ultimately be identified as natural or man made phenomena. However, even after careful analysis by skeptical investigators, a small number of reported sightings remain completely mysterious. Such a wide variety of observations fit in this unexplained category that one prominent investigator, Dr. J. Allen Hynek has sorted them into three main groups for convenience:

1. Close Encounters of the First Kind: In which the reported UFO is seen at close range but there is no interaction with the environment.
2. Close Encounters of the Second Kind: Are those where physical effects on both animate and inanimate material are noted, i.e., vegetation has been pressed down, burned or scorched, tree branches broken, animals frightened. Vehicles have become momentarily disabled. After the close encounter of the second kind left, the vehicles were usually able to operate again.
3. Close Encounters of the Third Kind: In which the presence of "Occupants" are reported in or about the UFO. There should be a distinction made between this type of report and the so-called contactee cases. The latter are characterised by a "favoured" human intermediary who believes he/she has been "chosen" by the space people as their regular contact to spread the messages they give to the contactee. These messages usually deal with such things as "be good, stop fighting, stop polluting the atmosphere and ban the bomb" etc. This later type of reporting is not classified as close encounters of the third kind.

Reference: Dr. J. Allen Hynek - "The UFO Experience" pgs. 28-31 inclusive.

In addition to the close encounter categories there are two broad groups.

Nocturnal Lights: Unidentified lights, seen at night, which usually only the relative brightness, color and motion are reported.

Daylight Disks: Unidentified objects, usually oval or disk-shaped seen during the day.

What do these close encounters and unexplained sightings mean?

There simply isn't enough conclusive evidence to give a good answer to that question but many people have theories or beliefs about what the answer should be.

II. The Problem of Objectivity?

Scientists usually attack an unexplained phenomena by thinking up a hypothesis that seems to explain what is going on. Then they do some experiments or make some observations which are critical tests of the hypothesis to determine whether it is true or false.

Very often in science, until the correct theory comes along or until a good set of tests are invented, several hypotheses will exist side by side to explain some phenomena. This is exactly what seems to be happening in the case of Unidentified Flying Objects. There are several hypotheses but so far the process of supplying critical tests hasn't really begun.

Unfortunately, some "investigators" of unidentified flying objects have already made up their minds about the phenomena. Rather than seeking the critical tests for their theory, they pick out bits and pieces of evidence that seem to prop up their ideas and they use these bits and pieces to sell their beliefs in sensational articles and books. Some of these "investigator's" tales might make gripping or even scary reading, but they do little to solve the problems of what U.F.O.s are. We recommend that all books and articles be read with a very critical mind. The mere fact that a statement or even a picture exists on a printed page does not guarantee that it is true. A good author will always state the sources of his information. But even if this seems to be done you still have to ask "do his sources seem to be reliable?" "Am I hearing all sides of the story or only the facts that fit this theory?" Uncritical beliefs may ease the mind by erasing the doubts and questions but they do absolutely nothing to increase our knowledge about U.F.O.s.

III. The Evidence Problem

In August 1972 a meteor so bright that it could be seen in full daylight, went streaking across the skys of North America. It appeared suddenly, was visible for scant minutes, and then disappeared. Yet the eye witness reports of this phenomena and the photographs by amateur photographers were so complete that Astronomers who studied the reports could learn almost everything they wanted to know about the object.

Astronomer and exobiologist Carl Sagan has pointed out that U.F.O.s are seen frequently by large groups of people, yet none have been as well photographed and as well reported as this single rare meteor was. Why not? There's no easy answer to that question.

Psychological suggestion deserves more study than it has received thus far. Any stage hypnotist can easily demonstrate the power that an authoritarian figure exercises over a susceptible subject, even to the extent of altering the subjects perception. It could be that pre-conceived or even subconscious notions of what U.F.O.'s are, effects our reports. Even ignoring the less obvious psychological problems, there's another problem with U.F.O. evidence.

Since the photographs are poor, most of the evidence consists of eye witness reports. Unfortunately, eye witness reports tend to be highly unreliable. And this is true of eye witness reports of just about everything, not only U.F.O.'s. A law professor once demonstrated this to his class by arranging a "crime" to take place in front of them. When the class convened, one of the students got up, "shot" the professor with a blank cartridge and fled from the room. After allowing the confusion to continue for a minute or two the professor revealed that he was unhurt. That day's assignment was to write an exact account of what each student had seen. At the end of class the professor collected as many different accounts of the event as there were students in the room, and the differences weren't minor either. In the confusion, some of the observers had even managed to switch, in their minds, the victim and the assailant.

IV. Recording and Reporting a U.F.O.

If you see a U.F.O. it is important to get as many other witnesses as possible. If you have a camera handy be sure to take lots and lots of pictures. Along with your observation of the object, U.F.O. investigators will want to know the date, the time, the weather conditions, the shape of the object, its color, its behaviour and motion, and its size compared to the size of objects that you can see around you while observing it, and its apparent speed. They will also be interested in the duration of the appearance and how the object disappeared.

If there are a number of witnesses record their names, addresses and telephone numbers. As soon as you can, try and make a drawing of the object to keep the event fresh in your mind. Once you are satisfied that the U.F.O. is really unidentified and not just an unusual look at something familiar like an airplane, the planet Venus, a weather balloon, a flight of birds over the city illuminated by street lights at night, then call the Manitoba Planetarium at 190 Rupert Avenue, Winnipeg, Manitoba, Canada, R3B ON2, area code 204-956-2830 during business hours and ask to talk to a representative of the Manitoba Centre for U.F.O. Studies. Reports are accepted in confidence and no details relating personally to the witnesses or associated parties will be made public, without written authorization from the individuals concerned. Remember, to be of use, reports must be complete. All of the information listed above is needed to make further study possible.

Over 90% of the things that people report as U.F.O.'s can be explained. This is partly due to the fact that many are simply unfamiliar with the ways the moon and planets and other celestial objects appear overhead. A visit to the planetarium to enjoy the wonders and the splendors of the sky will help to make you a better observer of U.F.O.'s.

V. Extraterrestrial Life

The most persuasive explanation for U.F.O.'s is that they are piloted or controlled by intelligences who inhabit some other place in the Universe besides the planet Earth. Present scientific knowledge does not exclude this possibility. Terrance Dickinson, reporting to the 1977 General Assembly of the Royal Astronomical Society of Canada has concluded that in our galaxy, The Milky Way, there are possibly four hundred earth like civilizations. That's an optimistic estimate, he also concludes that it's distinctly possible that we are alone. Dickinson's arguments are entirely statistical ones. The planets in our own solar system are the only planets that we have solid evidence for. Scientists have indirect evidence that there are planets about many other stars, but even the largest telescopes won't give us a look at any of these.

When we contemplate the idea of travelling to other stars, the problems seem very great. Travelling as close as we could to that Universal speed limit, the speed of light, it would take many years to reach even the nearest star, Alpha Centauri which is 4 1/3 light years away. Science Fiction writers have invented hyper-drives to the speed of light but these ideas remain science fiction. It may or may not be possible to exceed this cosmic speed limit. At the moment we simply don't know.

One thing is certain. If U.F.O.'s are space ships from elsewhere those controlling them have found ways to do things we find exceedingly difficult. This may be the case. However, its equally likely that some day those who believe that U.F.O.'s are interstellar visitors will be disappointed when it's established that U.F.O.'s are actually something far different, perhaps even something psychological rather than something physical.

Further reading:

HYNEK, Allen J.

The UFO Experience

The Hynek UFO Report

The Edge of Reality

VALLEE, Jacque

Challenge to Science, The UFO Enigma

Pass-Port to Magonia

Invisible College

FULLER, John G.

Incident At Exeter

Interrupted Journey

JACOBS, David Michael

The UFO Controversy in America

LORENSEN, Coral & Jim

Encounters with UFO Occupants
plus many other good UFO
books

There are hundreds of UFO and related books on the market. The above authors represent the best of these.

DEPARTMENT OF EDUCATION LIBRARY

Box 3, Main Floor
1181 Portage Avenue
Winnipeg, Manitoba
R3G 0T3

Phone: 786-0218 or
Toll Free WATS
1-800-262-8848

February 1981

ASTRONOMY

The following bibliography represents the holdings of the Department of Education Library in the area of "Astronomy". These materials may be obtained by submitting a request by mail, in person, or by telephoning the Library.

A. BOOKS

- 523.8 Asimov, Isaac. Alpha Centauri, the nearest star. New York,
A75 Lothrop, Lee & Shepard Co., c1976.
- E Asimov, Isaac. Galaxies. Chicago: Follett, 1968.
523.1
As
- 523.6 Asimov, Isaac. How did we find out about comets? New York, Walker,
A75 1975.
- E Asimov, Isaac. Mars. Chicago, Follett, c1967.
523.4
As
- E Asimov, Isaac. The moon. Chicago, Follett, c1966.
523.3
As
- 523.2 Asimov, Isaac. The solar system. Chicago, Follett, 1975.
A75
- E Asimov, Isaac. Stars. Chicago, Follett, c1968.
523.8
As
- 520 Asimov, Isaac. To the ends of the universe. Rev. ed. New York,
A85 Walker, 1976.
- 523.8 Baker, Robert H. Introducing the constellations. Rev. ed.
New York, Viking Press, 1957.

A. Books (con't)

- 520.151 Beet, Ernest Ager. Mathematical astronomy for amateurs. 1st
B42 American ed. New York, Norton, 1972.
- 520 Bova, Benjamin, Starflight and other improbabilities. Phila-
B68 delphia, Westminster Press, 1973.
- E Branley, Franklyn M. The big dipper. New York, Thomas Y.
523 Crowell, 1962.
Br
- 520 Bruck, Mary T. The night sky. Loughborough, Wills & Hepworth,
B7 1965.
- 523.2 Butler, Stuart Thomas. Family of the sun. Garden City, N.Y.,
B87 Anchor Press, 1975.
- 523.8 Crosby, Phoebe. Junior science book of stars. Champaign,
Cr Illinois, Garrard, 1960.
- 372.35 Daytime astronomy: teacher's guide. New York, McGraw-Hill,
E44 cl971.
v.16
- 523 Evans, David Stanley. Astronomy. 4th ed. Hodder & Stoughton,
E83 1978.
- 523 Fenton, Carroll Lane. Worlds in the sky. New York, John Day,
Fe 1963.
- 523 Freeman, Mae. Fun with astronomy. New York, Random House, 1953.
Fr
- 523 Freeman, Mae. The sun, the moon, and the stars. Random House,
Fr 1959.
- 523 Gallant, Roy A. ABC's astronomy: an illustrated dictionary.
Ga New York, Doubleday, 1962.
- 500 Gross, Jesse. Study lessons in general science. Chicago,
G76 Follett, 1968. v.
- 525 Hyde, Margaret. Exploring earth and space. 3rd ed. McGraw-
Hy Hill, 1957.
- 523.8903 Jobb, Jamie. The night sky book: an everyday guide to every night.
J62 1st ed. Boston, Little, Brown, 1977.

A. Books (con't)

- 523 Johnson, Gaylord. Story of planets, space and stars. New York,
Jo Harvey House, 1959.
- 523.00202 Joseph, Joseph Maron. Point to the stars. Rev. 2d ed. New York,
J67 McGraw-Hill, 1977.
- 520 Kerrod, Robin. The universe. New York, Warwick Press, 1975.
K47
- E Knight, David C. Let's find out about Mars. Franklin Watts,
521 1966.
Kn
- 520 Lovell, Alfred Charles Bernard. The individual and the universe.
Lo London, Oxford U., 1959.
- 372.35045 MacBean, John C. et al. Astronomy. Metric edition. Toronto,
E95 Holt, Rinehart and Winston of Canada Ltd., 1977.
v.1
- 372.35045 MacBean, John C. et al. Astronomy: teacher's guide. Metric
E94 t edition. Toronto, Holt, Rinehart and Winston of Canada Ltd.,
v.1 1976.
- 372.35 Mathews, William H., III. Helping children learn earth-space
M37 science; a selection of articles reprinted from "Science and
Children". Washington, National Science Teachers Association,
1971.
- 520 Mayall, R. Newton. A beginner's guide to the skies. Putnams,
Ma 1960.
- 523 Menzel, Donald Howard. A field guide to the stars and planets,
Me including the moon, satellites, comets and other features of
the universe. Boston, Houghton Mifflin, 1964.
- 520 Mitton, Jacqueline. Prentice Hall concise book of astronomy.
M58 Scarborough, Ont., Prentice Hall of Canada, 1978.
- 520 Moore, Patrick. Amateur astronomer's glossary. Lutterworth,
Mo 1967.
- 520.9 Moore, Patrick. Watchers of the stars: the scientific revolution.
M66 New York, Putnam, 1974.
- 520 Moore, Patrick. World around us. Abelard-Schuman, 1956.
Mo
- 522.2 Moore, Patrick. The young astronomer and his telescope.
M66 Shaldon, Devon, Keith Reid Ltd., 1974.

A. Books (con't)

- 520 Munch, Theodore W. What is a solar system? Collins, 1961.
Mu
- 520.76 Pickering, James Sayre. 1001 questions answered about astronomy.
P5 New York, Dodd, Mead, 1966.
- E Posin, Daniel Q. What is a star? Chicago, Benefic Press, 1961.
523.8
Po
- 523.89 Rey, Hans Augusto. Find the constellations. Boston, Houghton
R49 Mifflin, 1954.
- 523 Richardson, Robert S. Astronomy in action. McGraw, 1962.
R1
- 523.4 Ryan, Peter. Journey to the planets. Baltimore, Maryland,
R93 Penguin Books, c1972.
- 523 Sawyer, Hogg Helen. The stars belong to everyone: how to enjoy
S38 astronomy. 1st ed. New York, Doubleday, 1976.
- 520 Schmitz, Siegfried. Astronomy. London, Lutterworth, 1973.
S35
- E Shapp, Martha. Let's find out about the sun. New York, Watts,
523.7 1965.
Sh
- 523 Skilling, William T. Sun, moon and stars. 2d ed. New York,
Sk McGraw-Hill, 1964.
- 520 Strickland, Joshua. Superworlds. New York, Grosset & Dunlap,
S77 c1975.
- 372.35 Where is the moon?: teacher's guide. New York, McGraw-Hill, c1968.
E44
v.55
- 523 Wyler, Rose. The new golden book of astronomy: an introduction
Wy to the wonders of space. New York, Golden Press, 1965.
- 523.6 Zim, Herberts. Comets. New York, William Morrow, 1957.
Z1
- 523.7 Zim, Herbert. The sun. New York, William Morrow, 1953.
Z1

A. Books (con't)

523 Zim, Herbert Spencer. Stars: a guide to the constellations, sun,
Zi moon, planets and other features of the heavens. New York,
 Golden Press, 1956.

E Zim, Herbert Spencer. The universe. Newly rev. ed. New York,
520 Morrow, 1973.
Z55

B. AUDIO-VISUAL MATERIAL

VR The cosmic connection. OECA, c1975.
550 1 tape cassette, 30 min.
P53
v.4

VR Eclipse '79. (Videorecord) University of Winnipeg, 1978.
523.38 1 tape cassette, 38 min. color 3/4".
E24

VR Eclipse '79. (Videorecord) University of Winnipeg, 1978.
523.38 1 tape, 28 min. color 1/2".
E24 r

VR Eclipses. (Videorecord) University of Winnipeg, 1978.
523.38 1 tape cassette, 24 min. color 3/4".
E25

VR Eclipses. (Videorecord) University of Winnipeg, 1978.
523.38 1 tape, 24 min. color 1/2".
E25 r

K National Geographic Society. An introduction to the amazing
523 universe. Washington, National Geographic Society, 1978.
I57 2 filmstrips, 2 sound cassettes, 2 guides.

K National Geographic Society. The moon. Washington, D.C.,
372.4 National Geographic Society, c1978.
L41 m 1 filmstrip, 1 cassette, 3 study prints, 10 masters (Learning
 shelf kit).

K The new solar system. Stamford, Conn., Educational Dimensions, 1976.
523.2 2 filmstrips, 2 audiotapes, 1 teacher's guide.
N48

B. Audio-Visual Material (Con't)

K Our planet the earth. New York, Filmstrip House, c1966.
910 6 filmstrips, 2 sound discs, 1 discussion guide.
097

K The solar system. Carson, Calif., Educational Insights, c1975.
523.207 52 cards, 1 index box.
S64

VR Space study. Manitoba School Broadcasts and CBC, 1975.
520 3 tape cassettes, 30 min. each color.
S63

K Studies in science set 2. Glendale, Calif., Walt Disney Educational
520 Materials, c1968.
S79 7 filmstrips, 7 audiotapes, 7 filmstrip study guides.

K The view from spaceship earth. La Verne, Calif., David Chandler,
523.89 c1978.
V53 1 chart, 1 viewer.

16 MM FILMS FROM SCHOOL FILM SERVICES

ABOUT ASTRONAUTS (11 min., color). Film footage from the Apollo lunar flights provides the visual base for the answers to the questions of a child's letter to NASA: Is being an astronaut really dangerous? The moon is not as big as the earth -- doesn't that mean people weigh less up there? How long is it before you come back to earth? Is moonwalking really that different from earthwalking? It takes a lot of people to launch a spaceship -- are all those people necessary? Is it true that scientists can learn more about the earth and the whole universe by studying the moon?
(1973) Primary to Jr. High.

AMAZING ADVENTURES OF GEMINI IV (10 min., b & w). (1965) Primary to Sr. High.

COMETS, METEORITES AND ASTEROIDS (11 min., color). Comets, Meteorites and Asteroids are called the minor members of the solar system. This film shows: 1) how astronomers have learned about these objects travelling around the sun; 2) what each group looks like; and 3) the place of each in the solar system. The film illustrates the newest objects in the solar system: Man-made or artificial, satellites.
(1962) Jr. High to Sr. High.

CONTROVERSY OVER THE MOON (16 min., color). The film presents the "controversy" concerning the geological make-up of the moon -- specifically the origin of large lunar craters. Two eminent scientists interpret available data and discuss reasons for their divergent views.
(1971) Intermediate to Sr. High.

EARTH, SUN, MOON & STARS - POSITION OF THE MOON (8 min., color). Actual pictures of the moon as well as space planetarium views show the moon as earth's nearest neighbour in space, explaining fully the major movements of the moon, its revolving and rotating, and the causes of moonlight. Demonstrations show the comparative sizes of the earth, sun and moon, and their relative distance from one another.
(1971) Intermediate to Jr. High.

ECLIPSE AT GRAND'MERE (10 min., b & w). The eclipse of the sun on July 10, 1963, drew scientists and amateur stargazers from far afield to the little out-of-the-way town of Grand'Mere, Quebec, a place where the total eclipse was to be plainly visible. This film presents candid camera views of the festivities with which the modest town greeted the influx of visitors, and also shows the once-in-a-lifetime spectacle of the moon inching across the face of the sun, to blot it out completely.
(1965) Jr. High to Sr. High.

ECLIPSES OF THE SUN AND MOON (11 min.). Stop-motion and time-lapse photography are used to bring an actual solar eclipse to the screen. An animation sequence reveals the cause and effect of a total solar eclipse.
(1966) Jr. High to Sr. High - Adult.

EDGE OF THE UNIVERSE, TO THE (22 min., color). An account of the construction, in Algonquin Park, Ontario, of a radiotelescope designed by Canada's National Research Council, and how it was used to measure, working simultaneously with the telescope of the Dominion Radio Astrophysical Observatory at Penticton, B.C., the first arc of a "quasar" (quasi-stellar radio source) at the outermost fringe of our universe. The success of this probe opened up new possibilities of astronomical enquiry.
(1973) Sr. High.

EXPLORING THE MOON (20 min., color). (1960) Intermediate to Sr. High.

FIRST MEN INTO SPACE (20 min., color). Solving the space survival problems. Recreates, with live photography, film animation, and scale models, the first American orbital space flight, and illustrates some of the problems of man's survival in this hostile environment. Shows how such problems as decreased air pressure, multi-weight, and weightlessness were studied and how solutions were applied by engineers to the first space capsule project.
(1962) Intermediate to Sr. High.

HOW WE EXPLORE SPACE (16 min., color). An introduction to the instruments astronomers use and the methods used to explore space and to study planets and stars. The instruments shown are the telescope, camera, spectroscope and photo-cell. The various planets are examined by these instruments. Also, included, are some of the first color pictures taken of Mars.
(1958) Jr. High to Sr. High.

HOW WE KNOW THE EARTH'S SHAPE (11 min., color). We use a globe as a model to represent the shape of the earth. But how do we know what the earth's shape really is? The film shows how, during the centuries, man has changed his ideas about what the earth looks like: from flat, to curved, to round, to flattened and bulging, to pear-shaped. Yet, a perfectly round globe is still the best model of the shape of the earth.
(1960) Elementary to Jr. High.

MILKY WAY AND BEYOND (20 min., color). Presents the relationship of our solar system to the galaxy of which it is a part. Telescopic color photography and effective animation illustrate what stars are and how they are formed. An expanding picture of the universe is gained as other galaxies and their movements are portrayed.
(1961) Intermediate to Sr. High.

MOON, THE (15 min., color). (1963) Primary to Intermediate.

OTHER PLANETS - NO PLACE LIKE EARTH (30 min., color). What are the similarities and differences between Earth and the other planets of the solar system? Computer animation is used to summarize the knowledge scientists have gained to date.
(1971) Intermediate to Sr. High.

RED PLANET, MARS (17 min., color). Animation and still photographs are used to show Mars in the solar system. Historical observations are cited. With diagrams for the space satellites, indication is given of how man may one day be able to get a closer view of the surface of the planet. Some details of the satellite Mariner indicate how close-ups of the planet will be secured and sent back to the earth.
(1971) Intermediate to Sr. High.

SATELLITES - STEPPING STONES TO SPACE (20 min., color). (1959) Intermediate to Sr. High.

SOLAR FAMILY, THE (10 min., b & w). Makes an introductory study of the planets - their evolution, motions, sizes and satellites. Describes with animated drawings the evolution of the solar system according to planetesimal hypothesis, and traces the real and apparent motions of the planets. Reveals special phenomena pertaining to certain planets, and describes the planetoids, Halley's comet, and the movement of the solar system.
(1936) Jr. High to Sr. High.

SOLAR SYSTEM (18 min., 2nd Ed.). This unusual animated film combines 3-dimensional models with "you-are-there" camera techniques to create an awesome sense of drifting through outer space.
(1978) Primary, Intermediate, Jr. High, Sr. High.

SUN AND HOW IT AFFECTS US (10 min., color). A comprehensive study of the sun is presented, including the sun's size, distance from the earth, physical nature, and its effect on life, weather, and tides on earth. A basic understanding of the probable origin and effects of the corona, prominences, flares, and sun-spots is provided through telescopic motion pictures.
(1958) Intermediate to Jr. High.

SUN AND THE SOLAR SYSTEM (20 min., color). Discusses asteroids, meteors, the sun and the nine planets in the solar system. Explains why a planet travels around the sun.
(1963) Primary to Intermediate.

SUN'S FAMILY (10 min., b & w). Explains the nature of the solar system, discussing the sun and the planets that travel about it.
(1950) Intermediate to Jr. High.

TRIP TO THE MOON (16 min., color). An imaginary rocket takes off to the moon and explores its surface. During the trip we learn many facts about conditions met in navigation to the moon. Once above the moon's surface, the film shows in detail the craters and "seas", the valleys and mountains that can be seen from the earth. The film combines animation and model photography to create a realistic illusion of a study of the moon's surface.
(1957) Intermediate to Sr. High.

UNDERSTANDING OUR UNIVERSE (11 min., color). How man has learned about the universe from ancient times until the present day is demonstrated by this film which discusses our knowledge of the universe - the solar system, Milky Way and countless other galaxies and nebulae that extend millions of light years into space.
(1957) Intermediate to Sr. High.

UNIVERSE (26 min., b & w). A triumph of film art, creating on the screen a vast, awe-inspiring picture of the universe as it would appear to the voyager through space. Realistic animation takes you out beyond our solar system, into far regions of space perceived by the modern astronomer. Beyond the reach of the strongest telescope, past moon, sun, Milky Way, into galaxies yet unfathomed, you travel on into the staggering depths of the night, astonished, spellbound at the sheer immensity of the universe. Starting point for this journey is the David Dunlop Observatory, Toronto.
(1960) Jr. High to Sr. High.

UNIVERSE (28 min.). A motion picture that explores almost inconceivable extremes of size and time - from the vast islands of stars called galaxies, to sub-atomic particles; from cosmic events that occurred billions of years ago to microcosmic events in the present that endure for only a billionth of a second.
(1978) Sr. High, College, General.

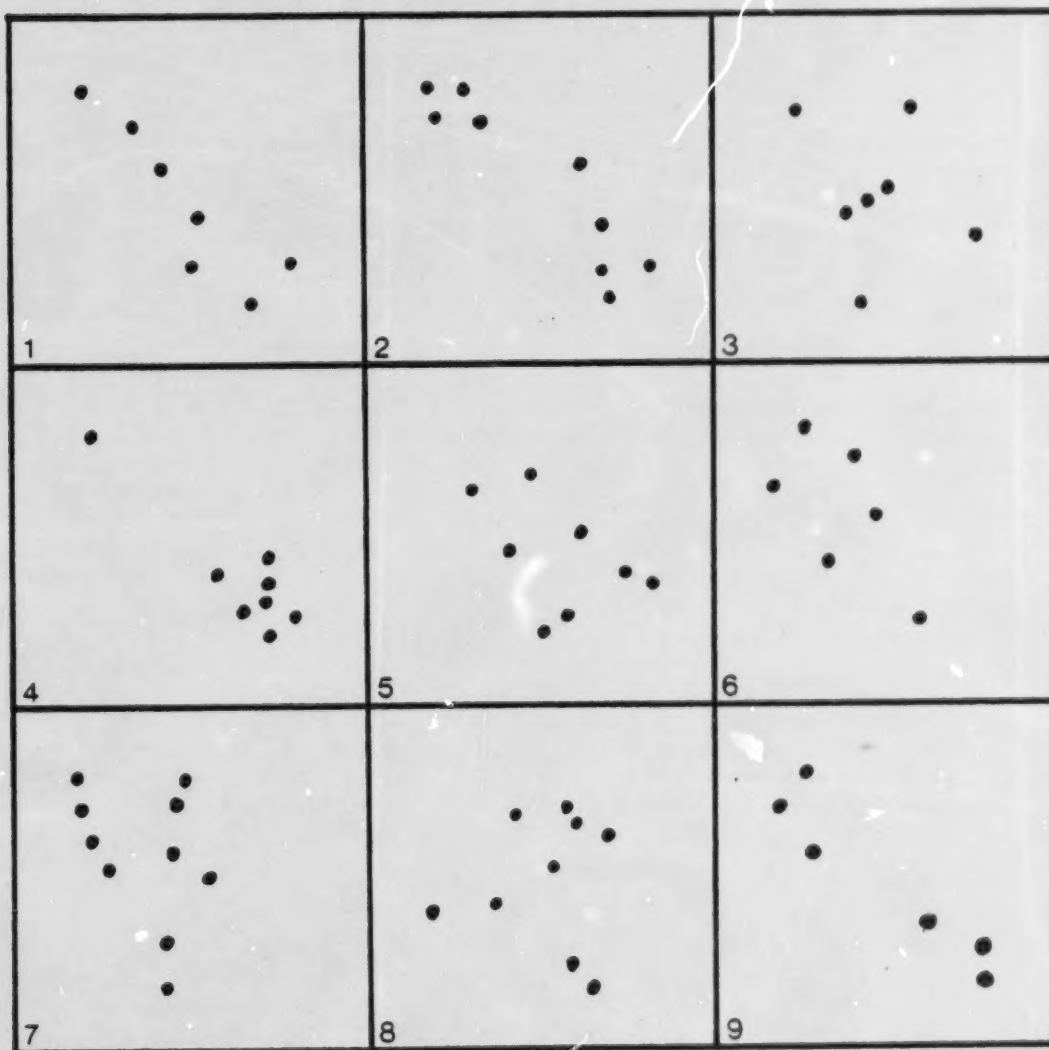
THE UNIVERSE: BEYOND THE SOLAR SYSTEM (18 min.). This film takes viewers on an exciting visual journey, beginning with our solar system and extending into and through the farthest reaches of outer space.
(1978) Sr. High.

Constellation Slides

To make constellation slides you need the following:

- glue
- construction paper
- scissors
- pointed object
- 35mm slide projector

1. Spread a thin coat of glue on the back of this sheet and affix it to a sheet of construction paper.
2. Label the constellations found in each box.
3. Separate the boxes.
4. Punch tiny holes (large enough to let light through) where stars are located.
5. Project these constellation slides in a 35mm slide projector.



ACTIVITIES

1. Challenge your friends to name the constellations correctly.
2. With a star map and using thin cardboard, make additional slides.

Constellation Cans

To make a simple constellation can you need the following:

- large tin can from juice (48 oz.)
- hammer
- nails of different thicknesses (about 5)
- flashlight
- constellation discs (found on the following pages)
- scissors

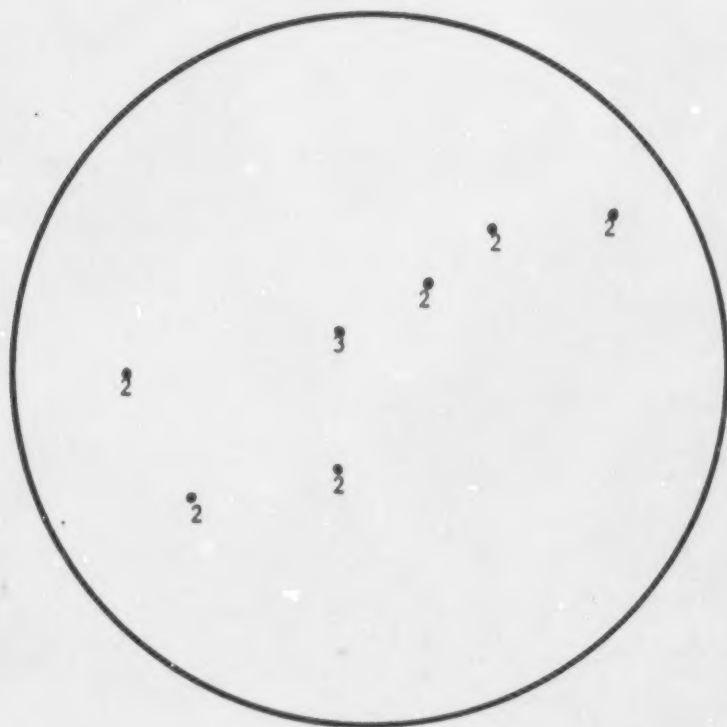
Cut out a constellation disc and place it on the bottom of the can.

Punch holes in the can at the positions marked for the stars. For larger stars use larger nails and for smaller stars use smaller nails to indicate the relative brightnesses of the stars.

Place the flashlight inside the can. When the room is darkened the image of the "stars" can be projected on the wall or ceiling.

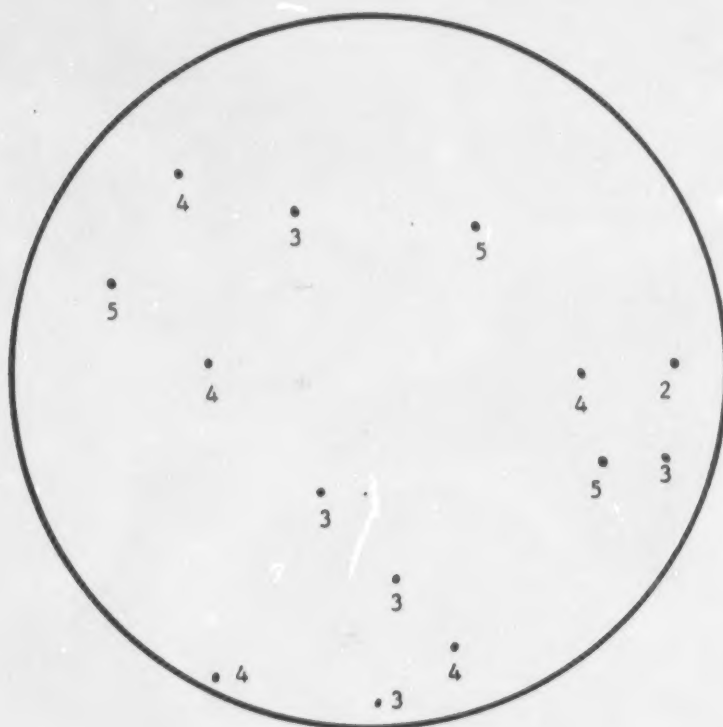
Students can project a large number of different constellations at one time on the wall and with the aid of a star chart they can simulate the sky with the constellations in the proper places in the sky.

URSA MAJOR



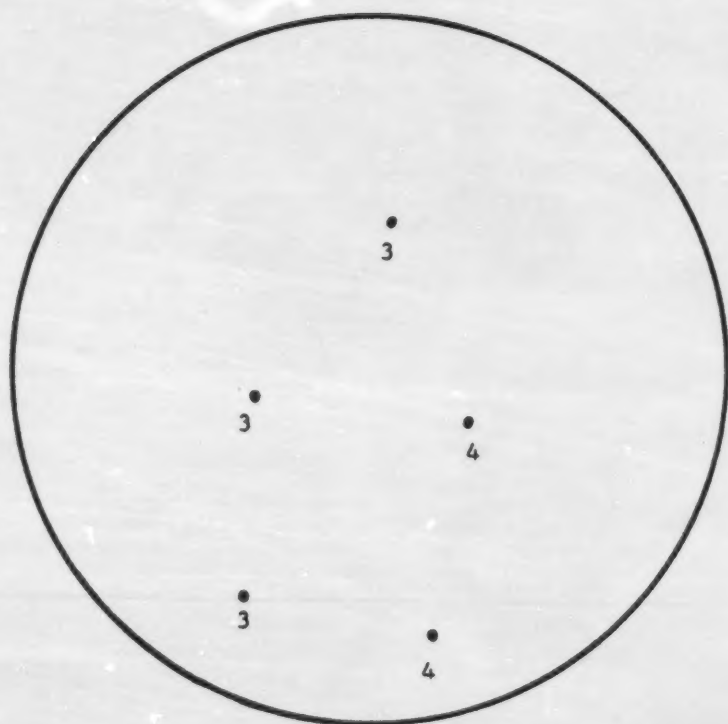
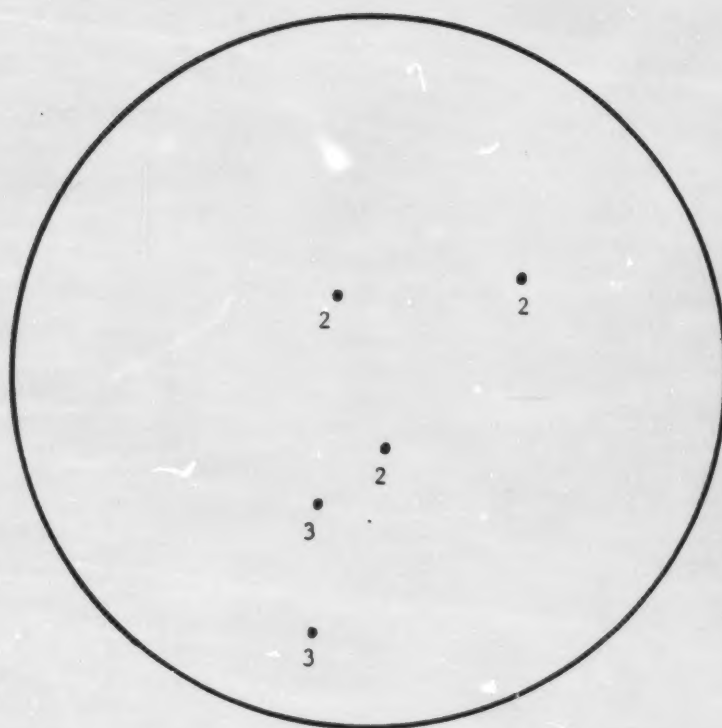
URSA MINOR

DRACO



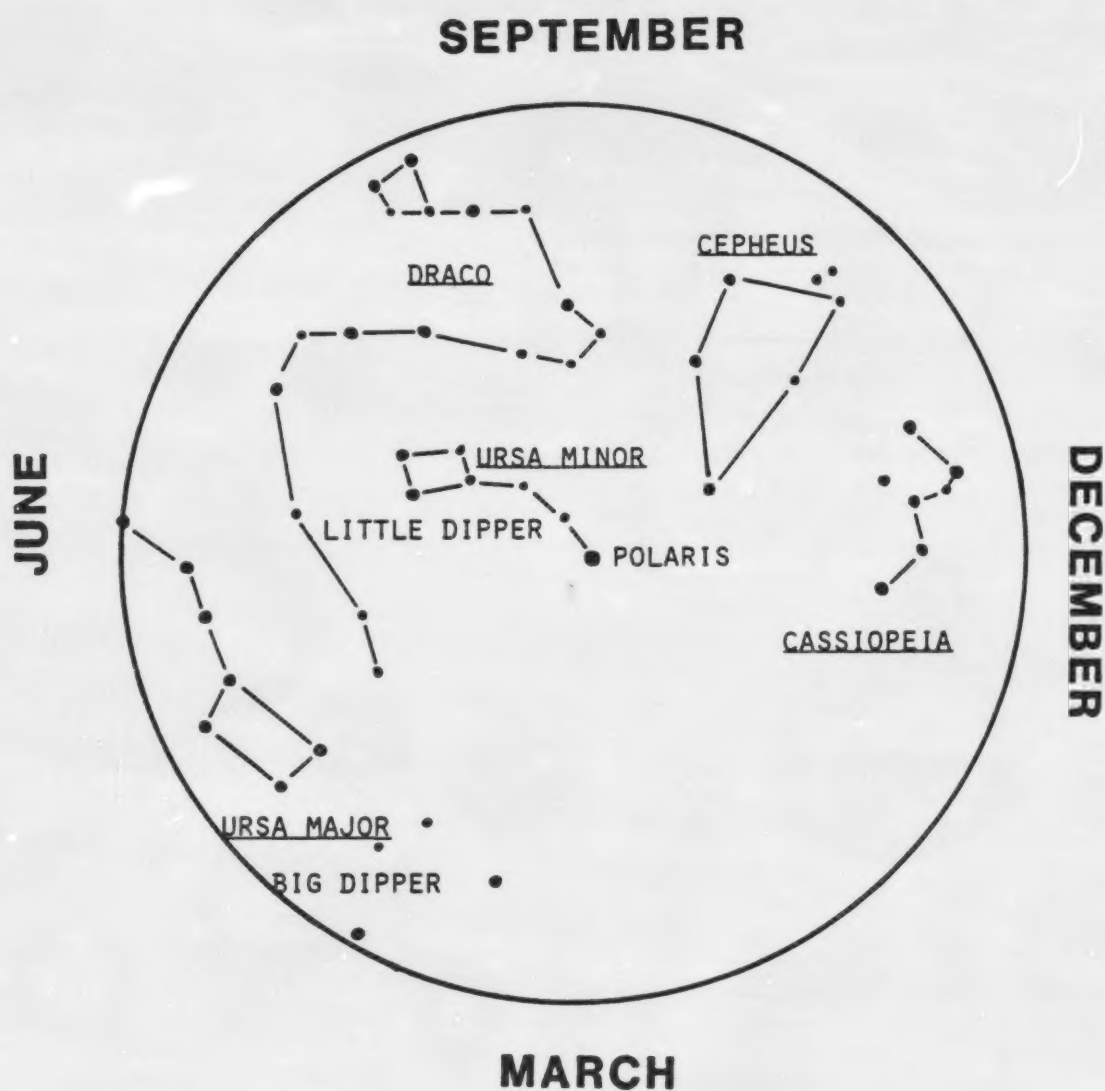
ORION

CASSIOPEIA

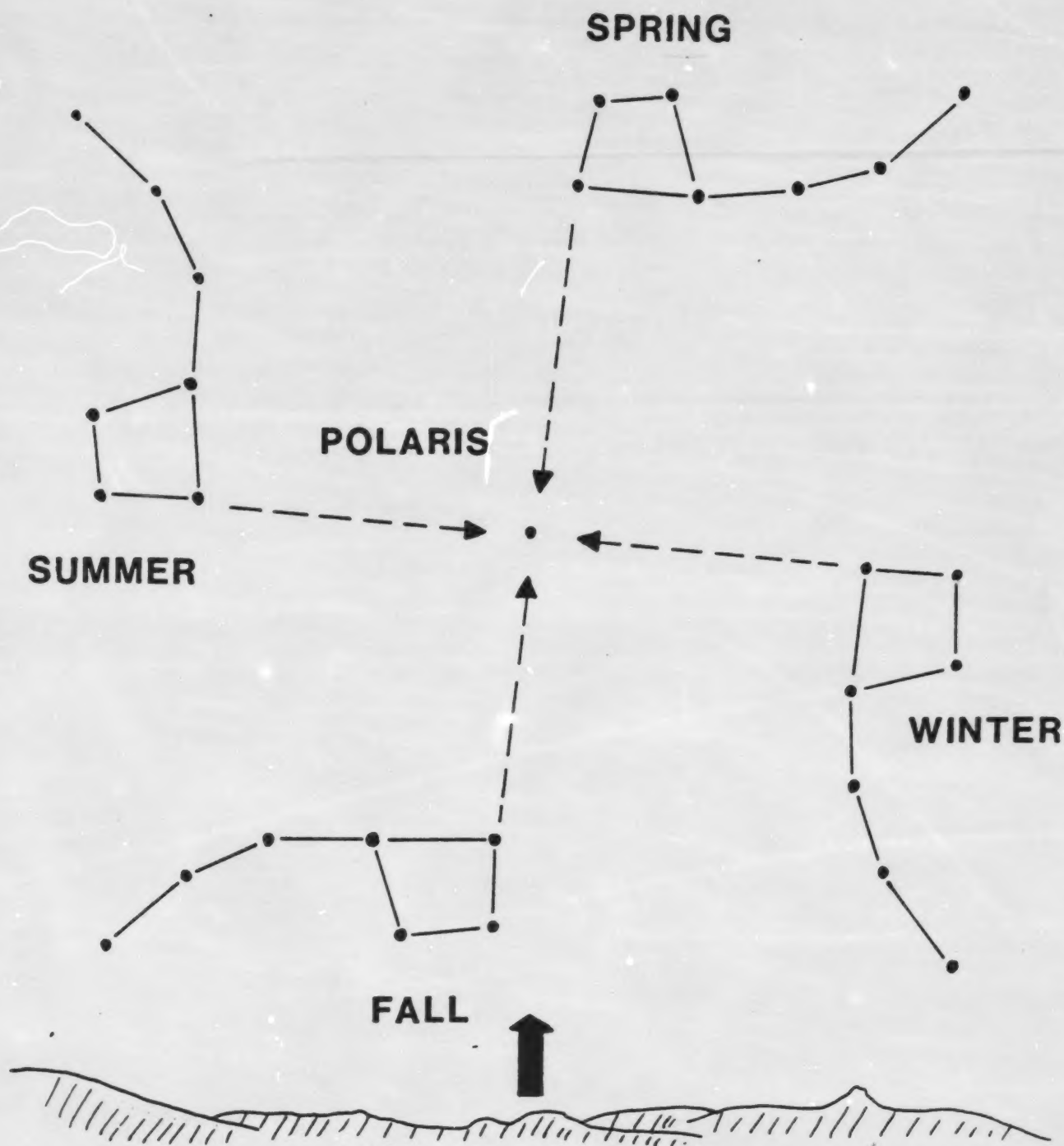


CEPHEUS

NORTH POLAR CONSTELLATIONS



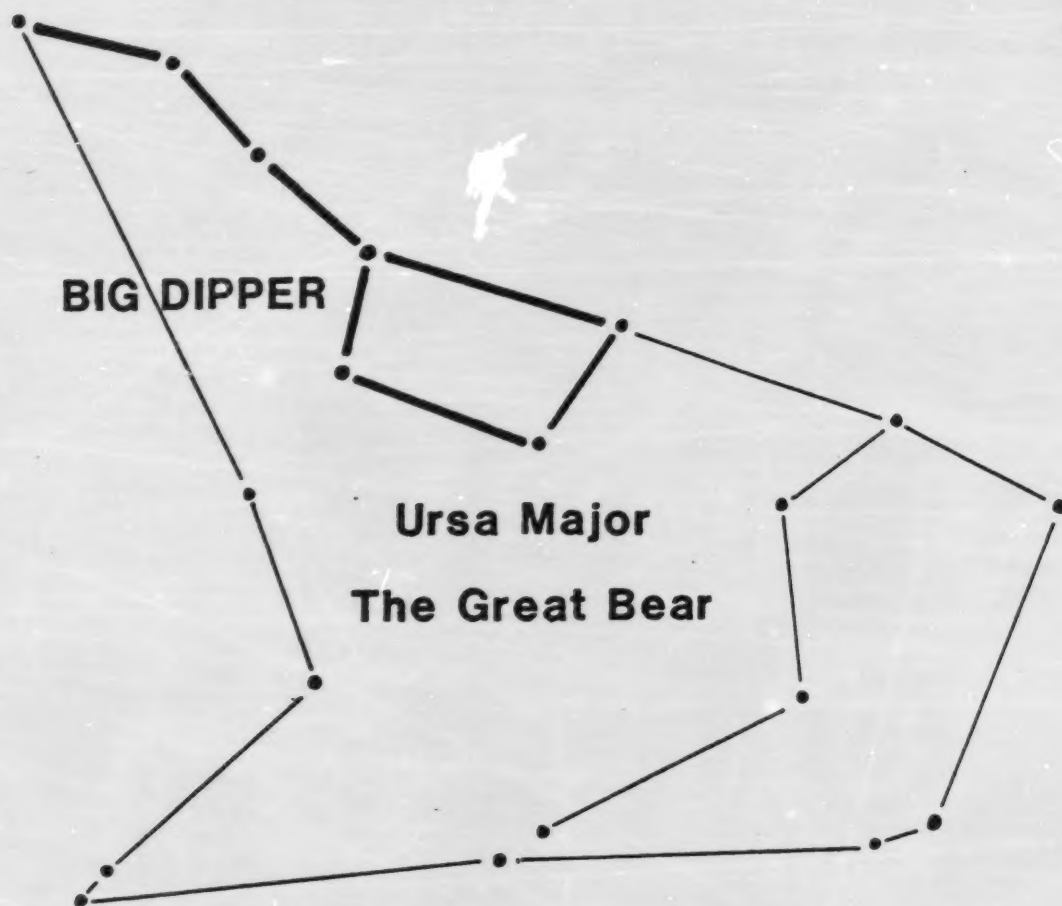
BIG DIPPER IN DIFFERENT SEASONS



LOOKING NORTH AT EIGHT P.M.

THE BIG DIPPER

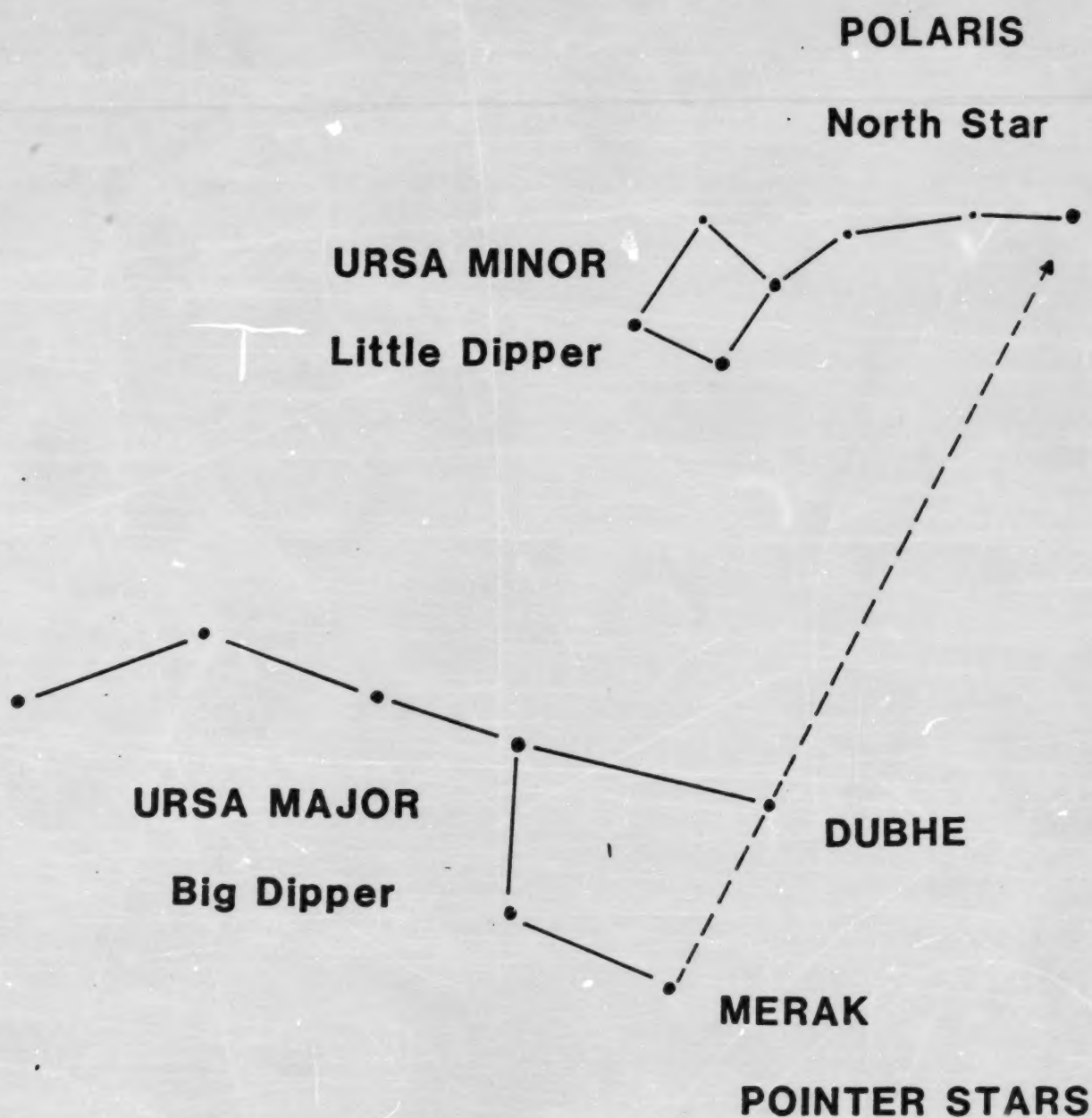
A Part of the Constellation Ursa Major



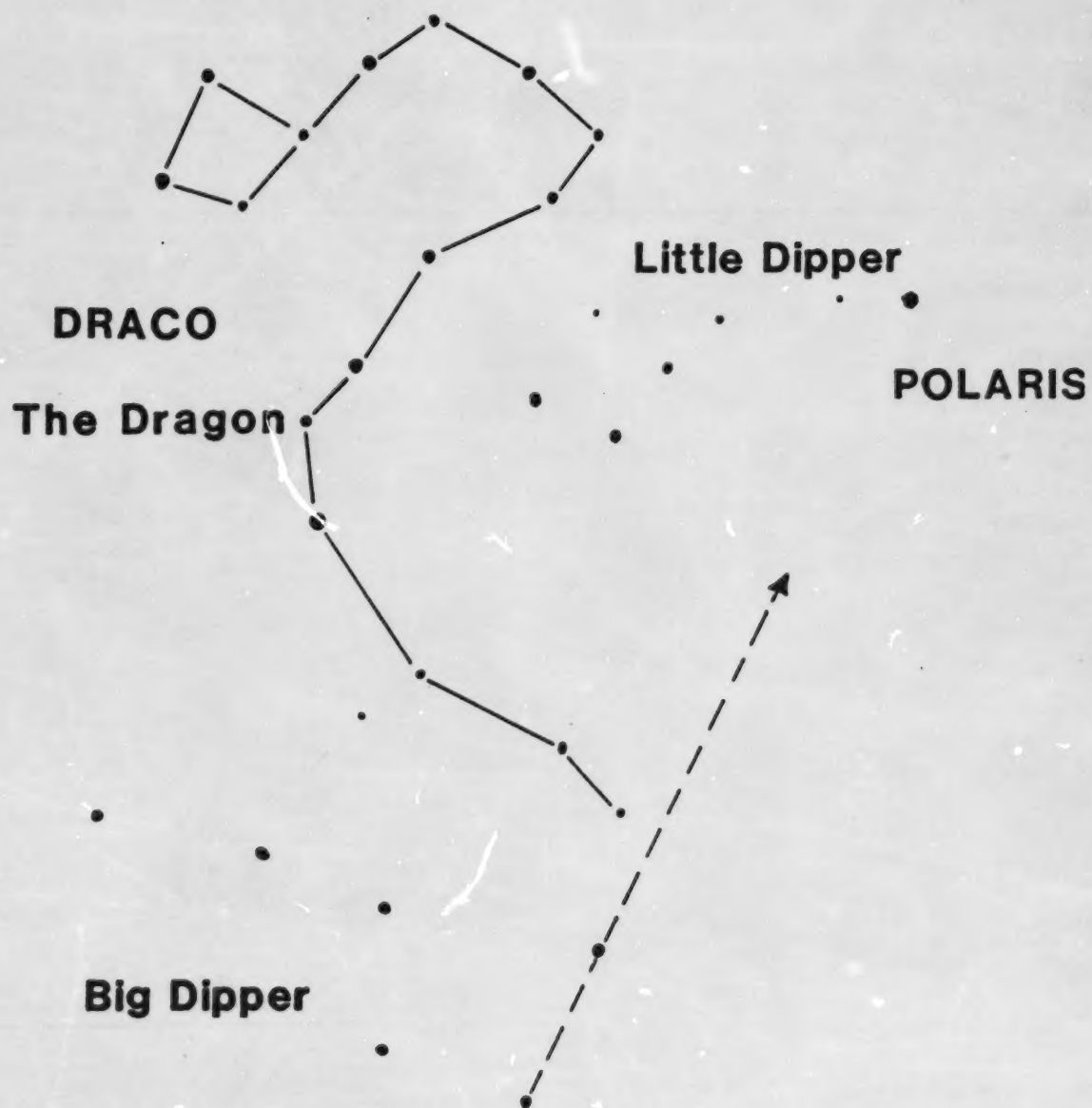
MONTH _____

SUMMARY :

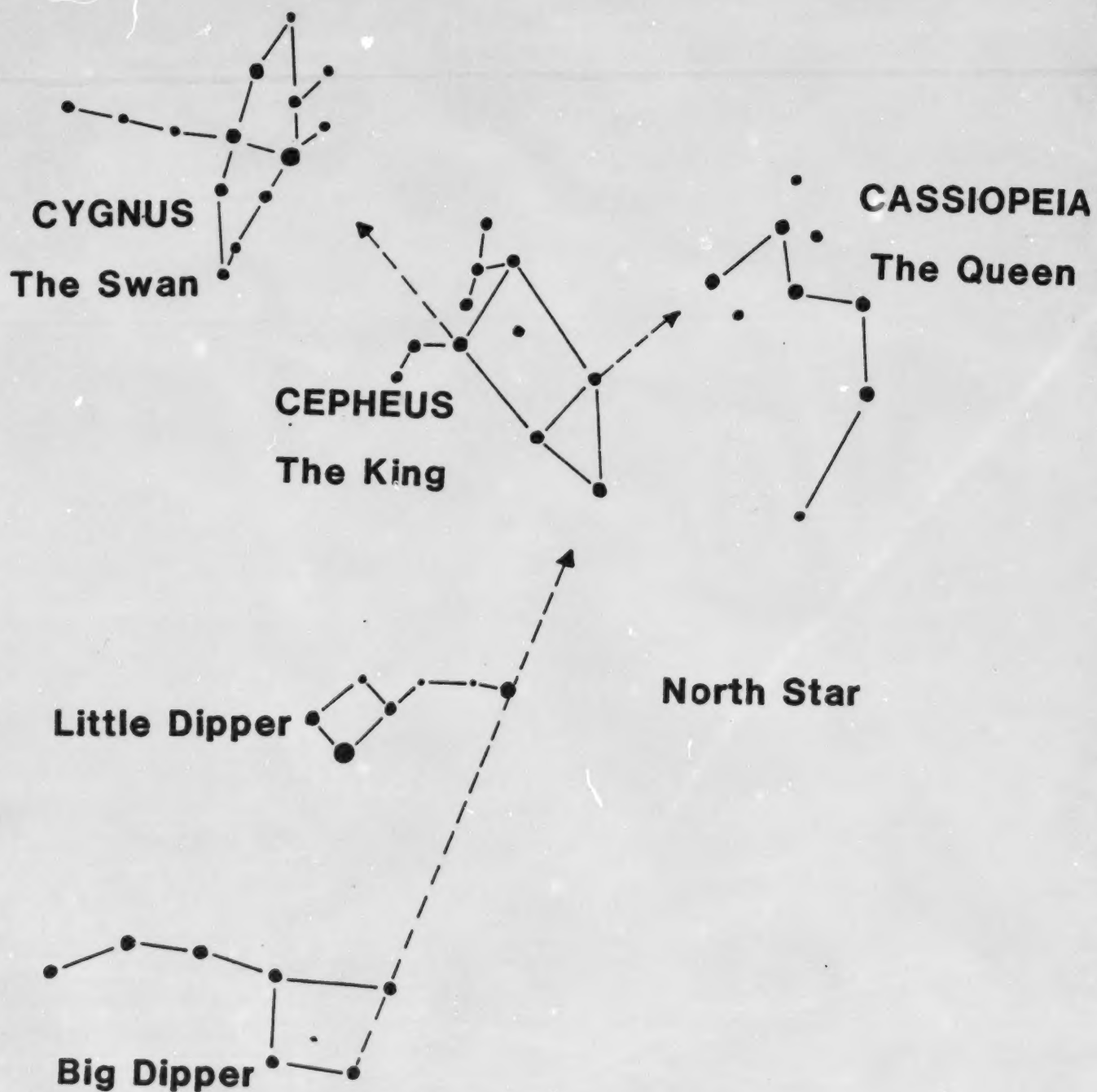
FINDING THE NORTH STAR



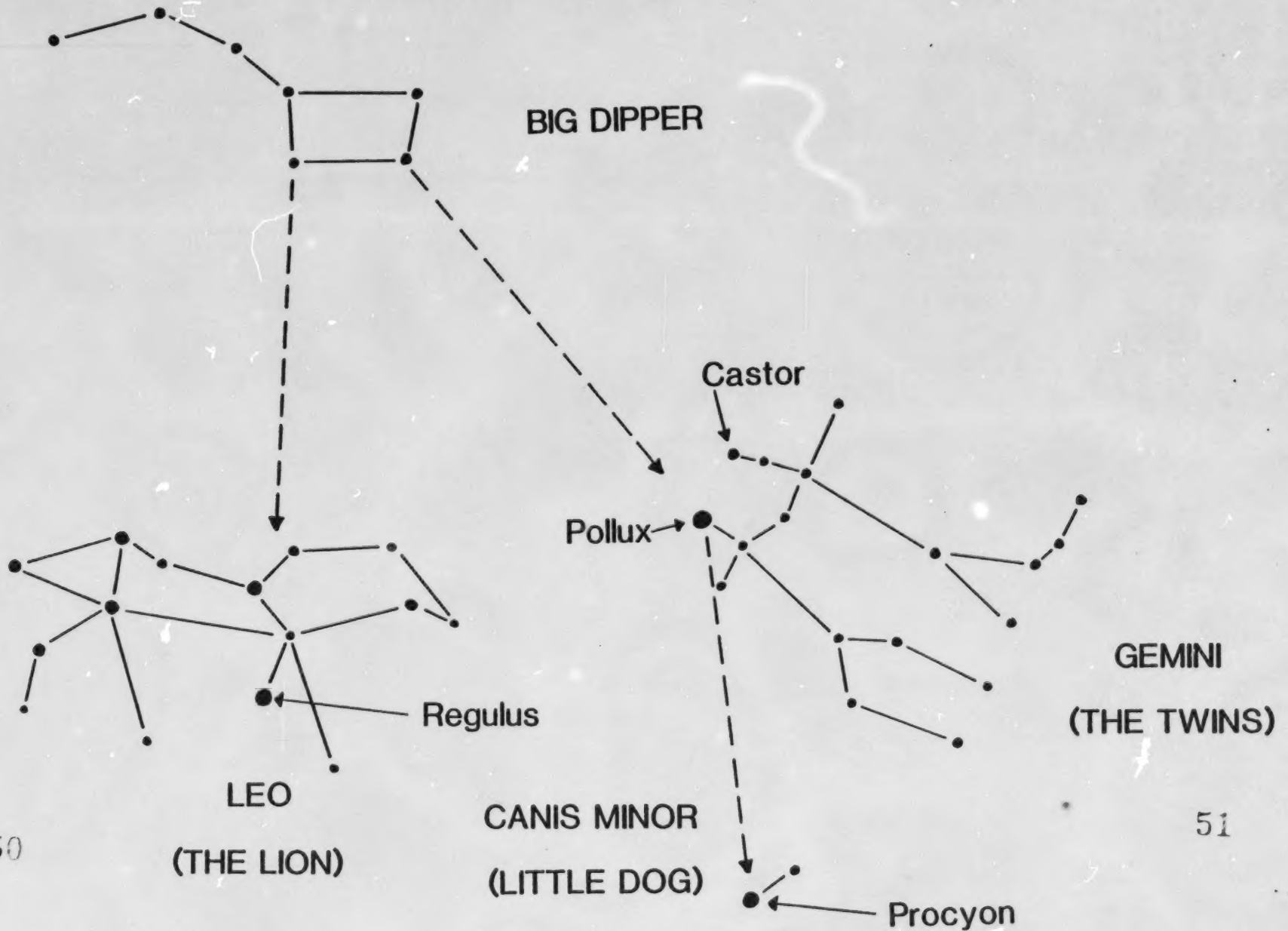
FINDING DRACO



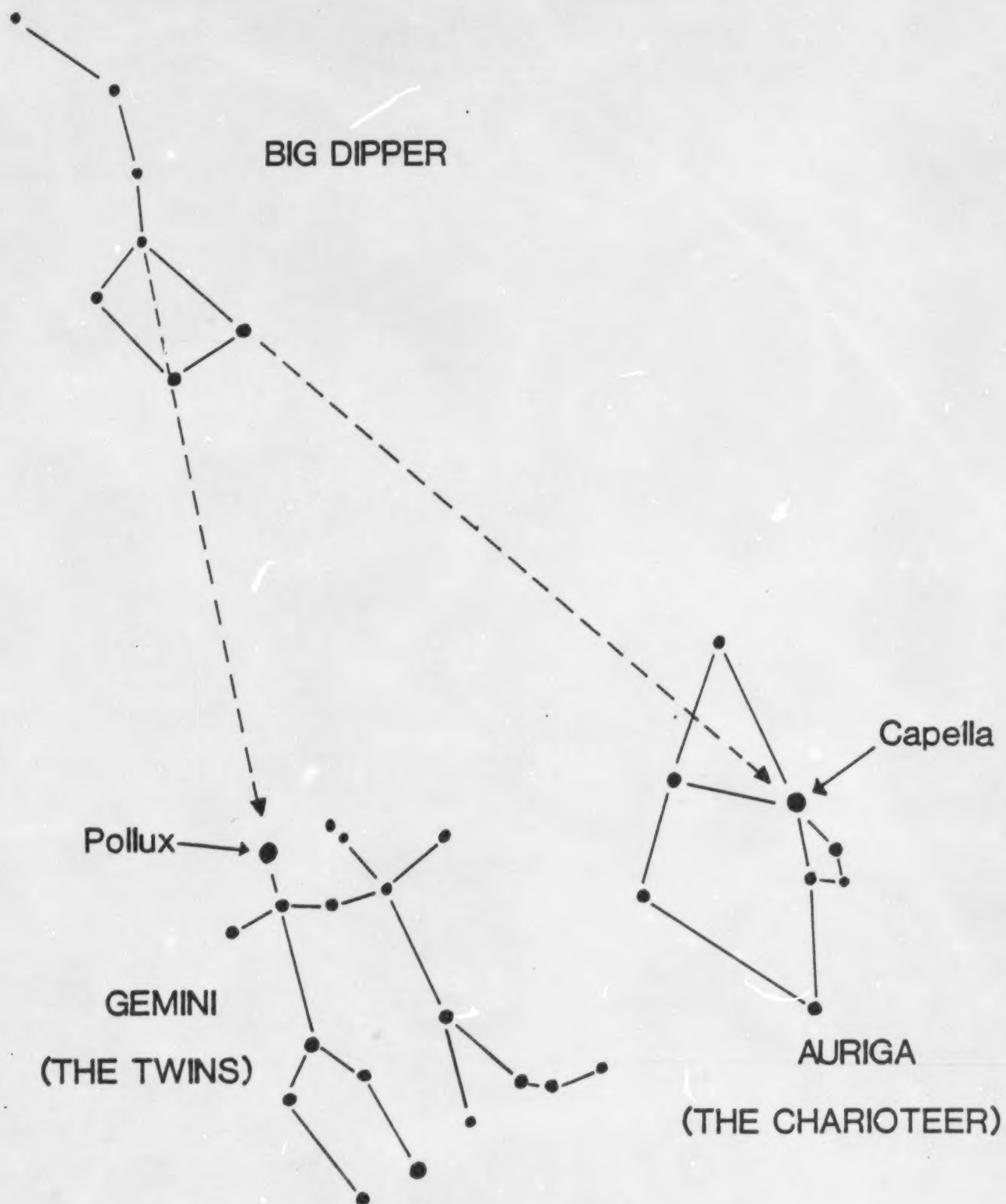
FINDING CEPHEUS, CASSIOPEIA, AND CYGNUS



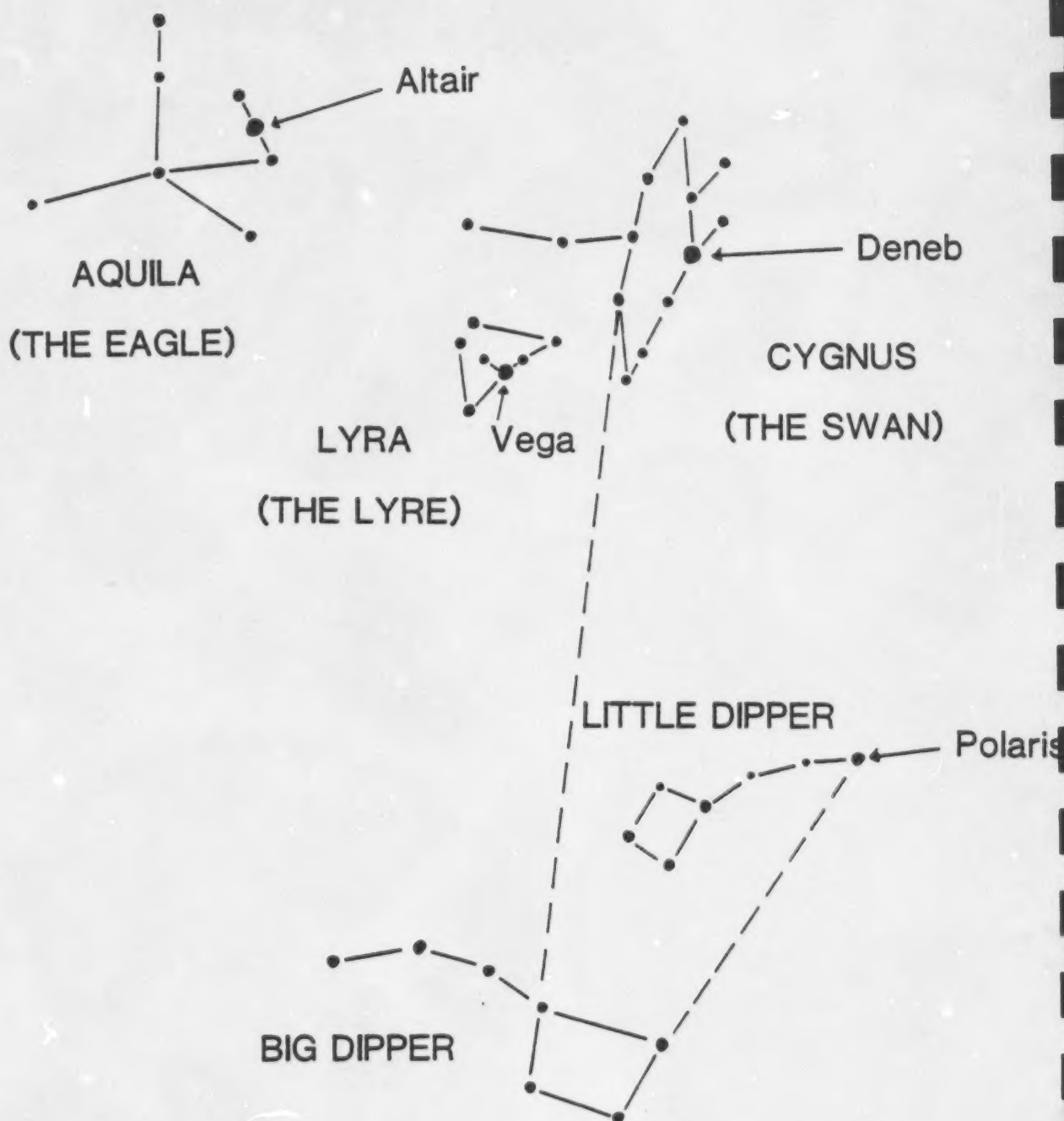
FINDING LEO, CANIS MINOR & GEMINI



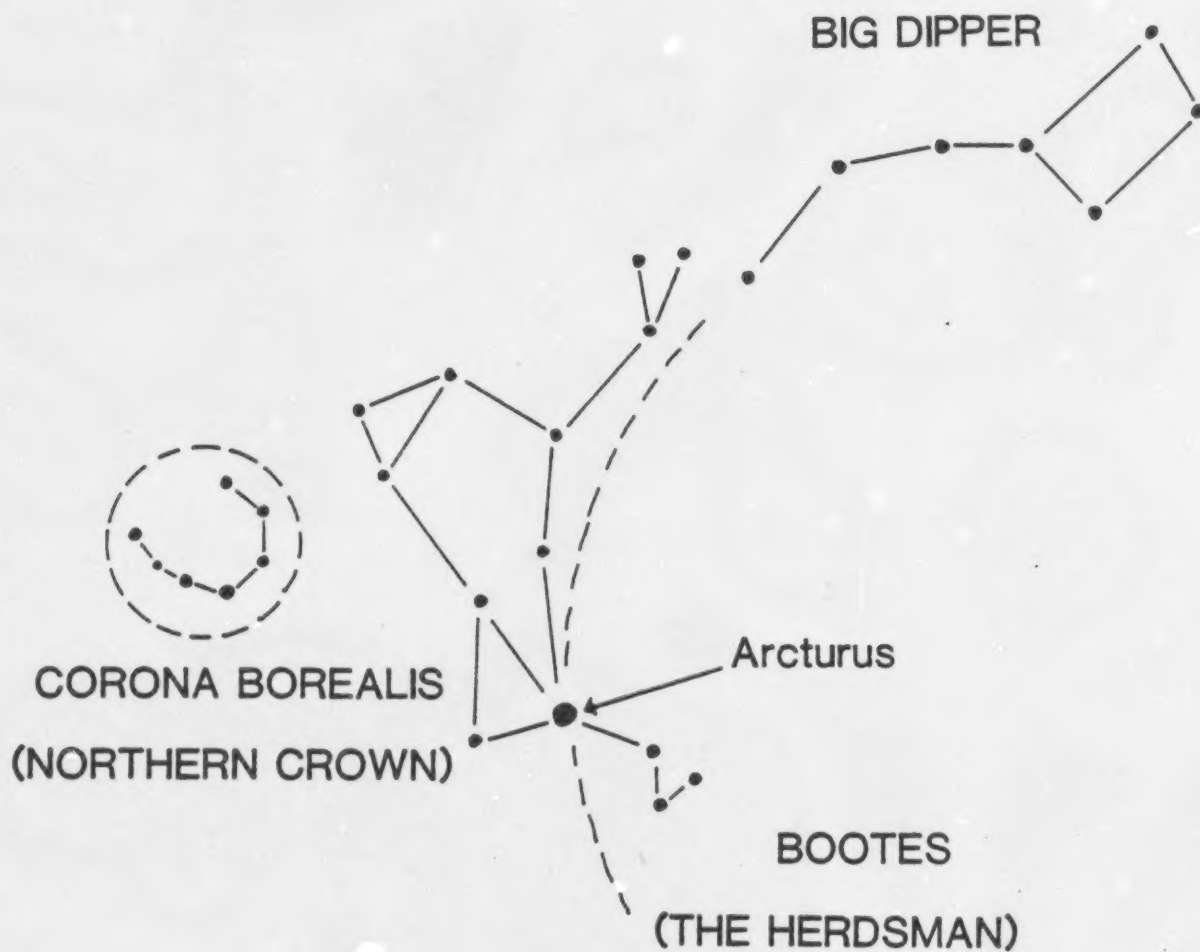
FINDING GEMINI & AURIGA



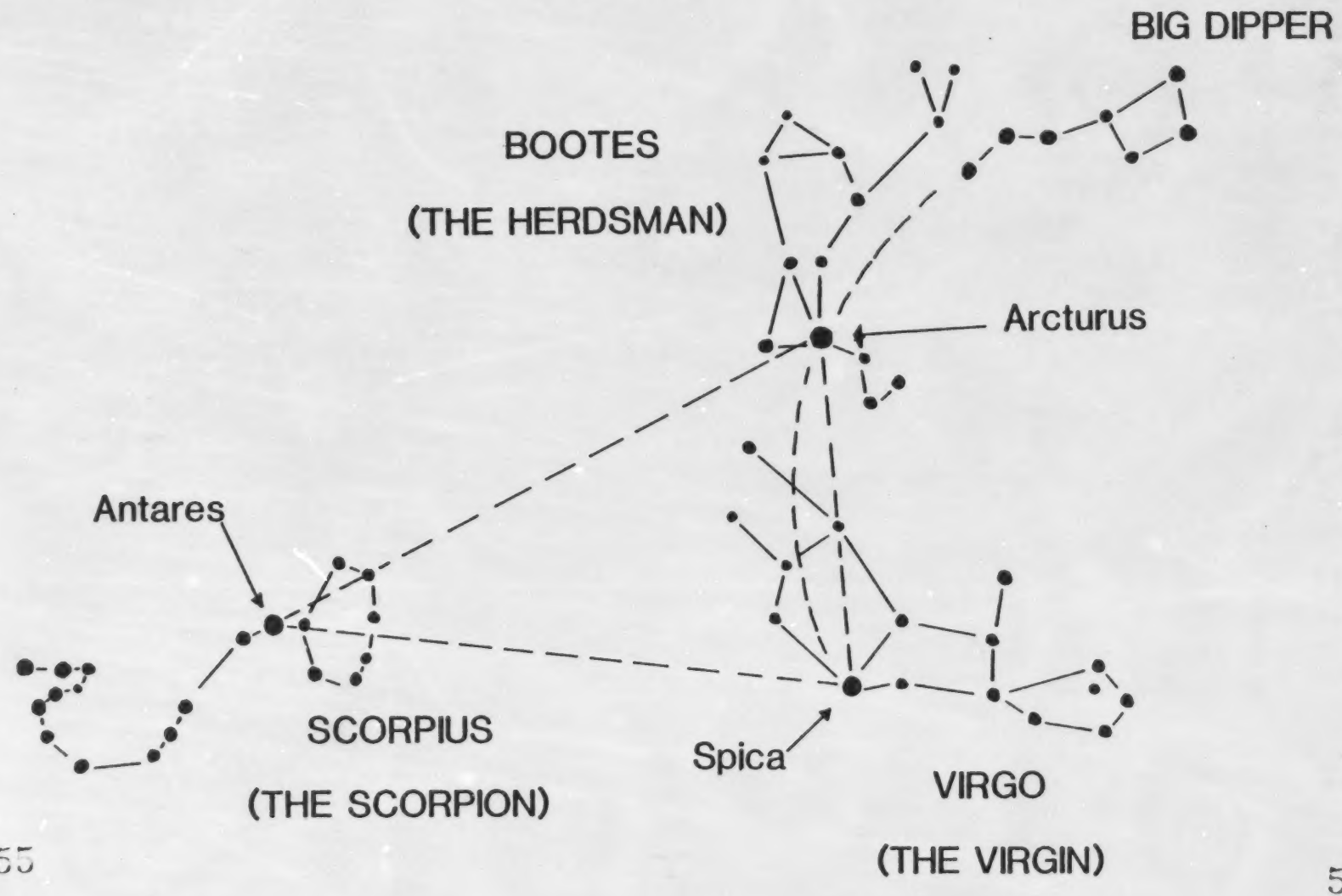
FINDING CYGNUS, LYRA & AQUILA



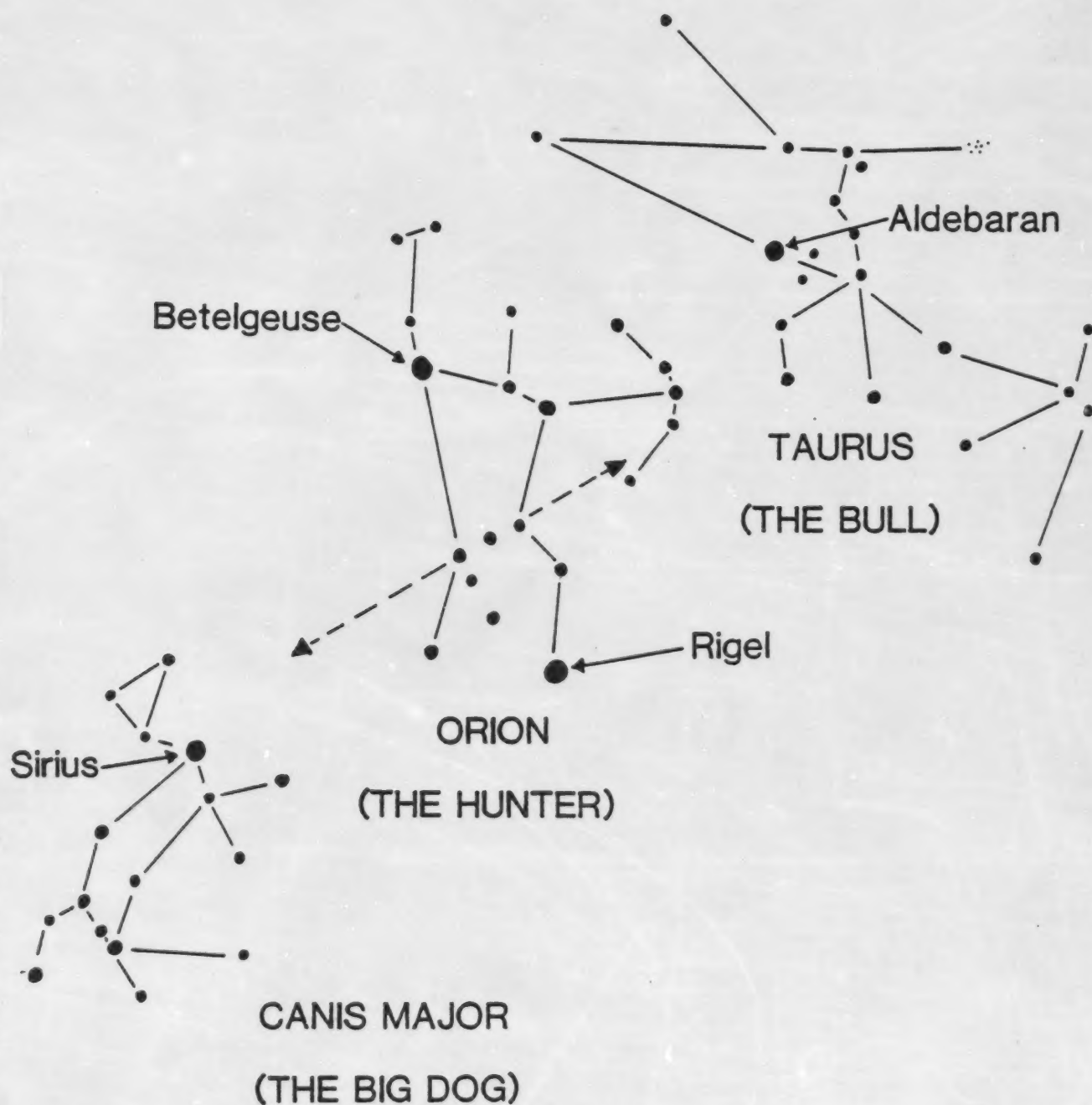
FINDING THE NORTHERN CROWN



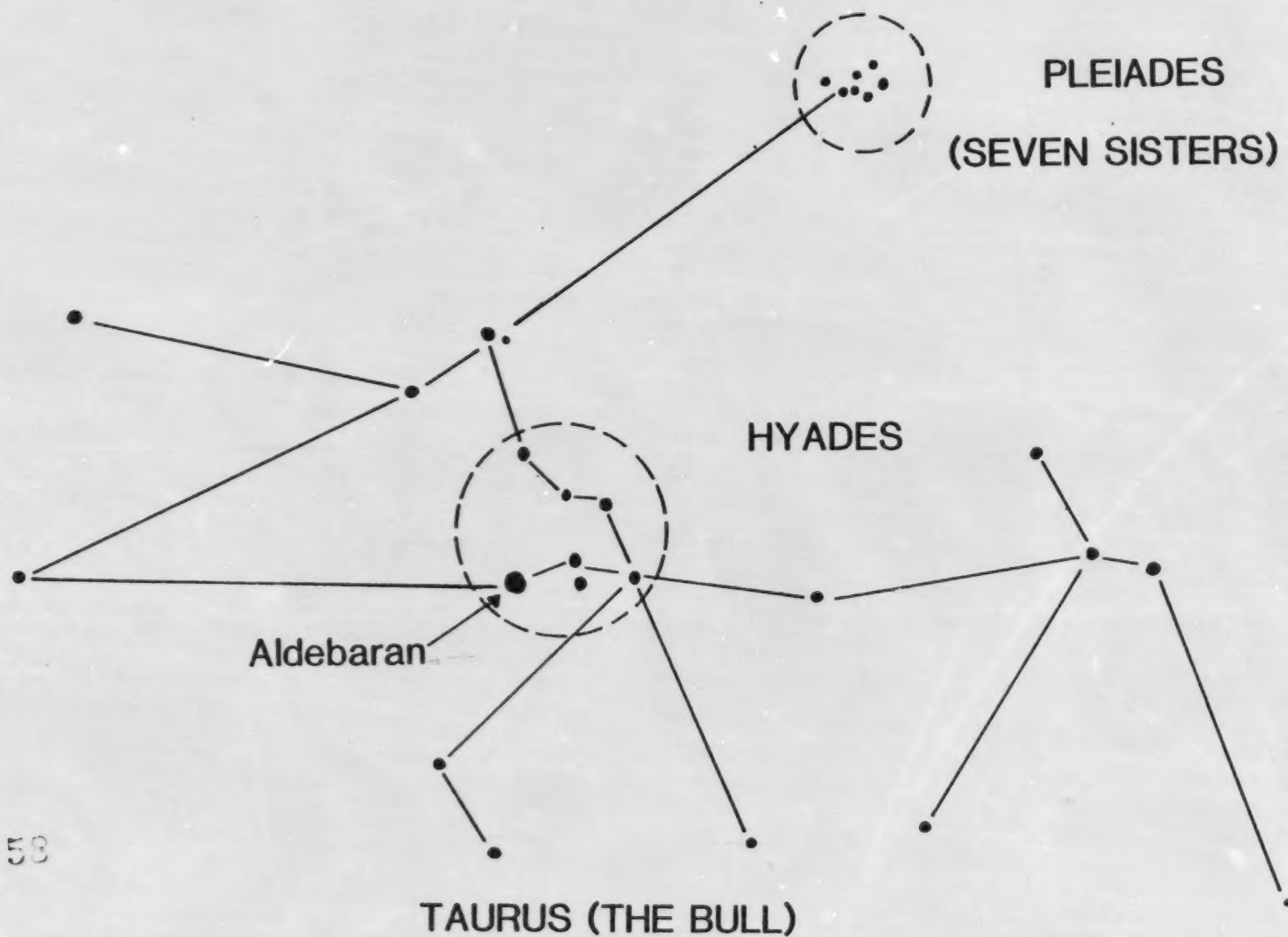
FINDING BOOTES, SCORPIUS & VIRGO



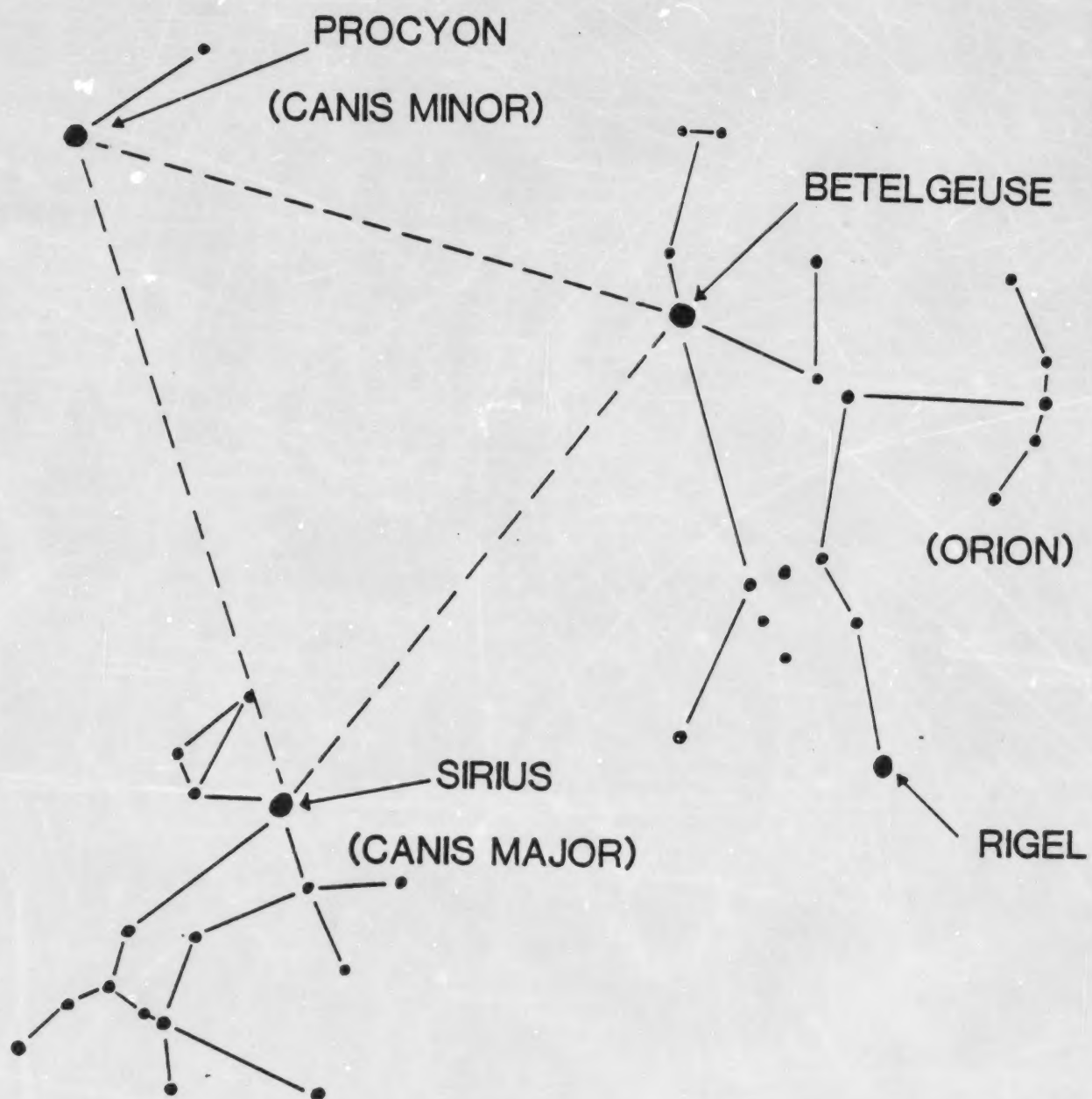
CANIS MAJOR, ORION & TAURUS



THE PLEIADES & HYADES



THE BIG TRIANGLE

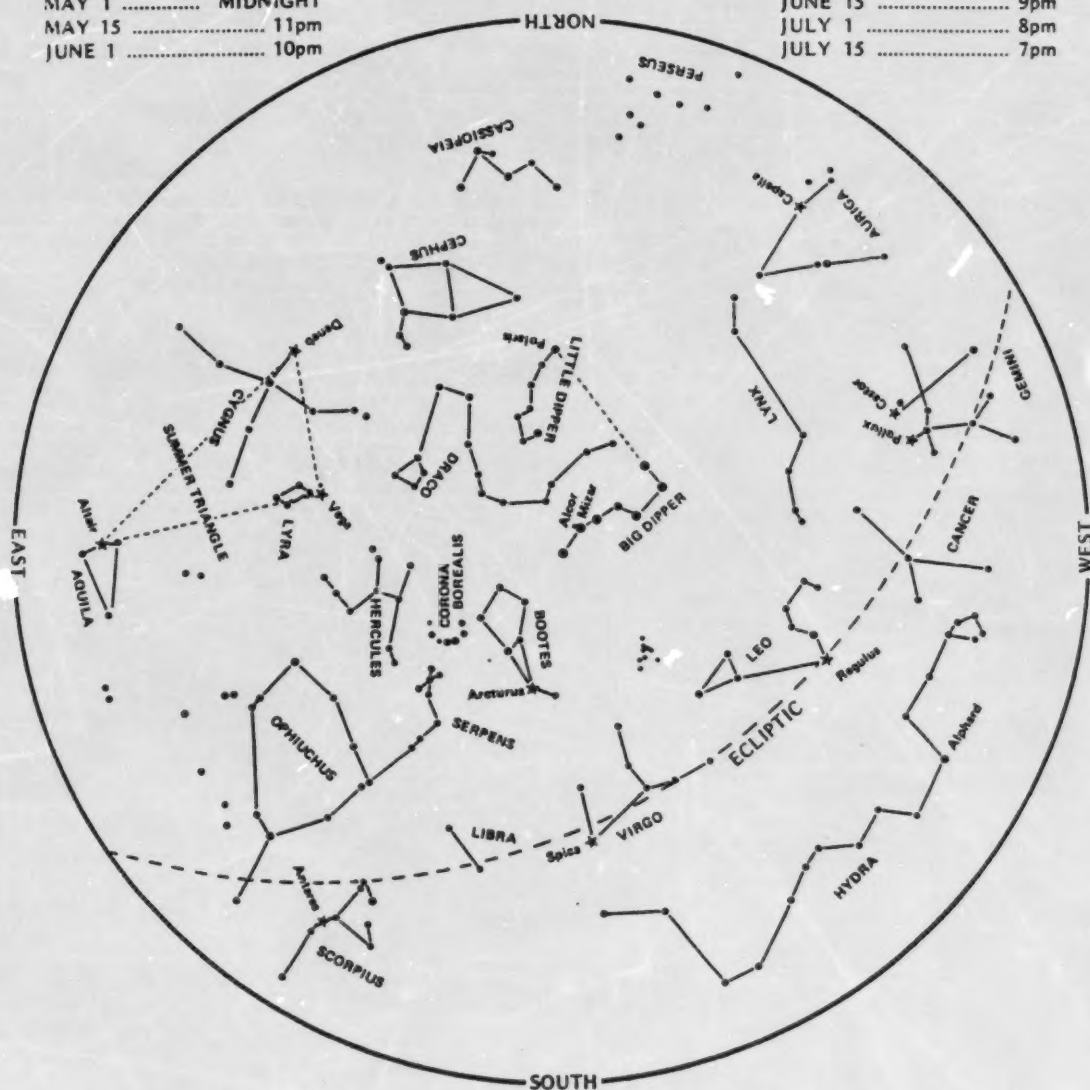


SPRING STARS

THIS STAR MAP WILL WORK BEST AT THESE TIMES:

MAY 1 MIDNIGHT
MAY 15 11pm
JUNE 1 10pm

JUNE 15 9pm
JULY 1 8pm
JULY 15 7pm



Hold the map overhead and turn it so that the directions marked around the map's horizons match the true directions. Try and find the brightest stars and constellations first, then the fainter ones. If any planets are visible they will look like bright stars. Planets are always found close to the ecliptic.

The objects marked like $\star$ M13 are objects such as galaxies, nebulae or star clusters. Under a dark country sky most of these can be observed with the eye alone. They are best observed with binoculars or a telescope.

For more information about sky watching, consult *The Sky Observers Guide* by Mayall, Mayall, and Wyckoff, The Golden Press, New York, 1965. A star map that will work all year, at any hour, is *Philip's Planisphere*. These and other helpful publications are available at the Museum Bookstore.

MANITOBA PLANETARIUM

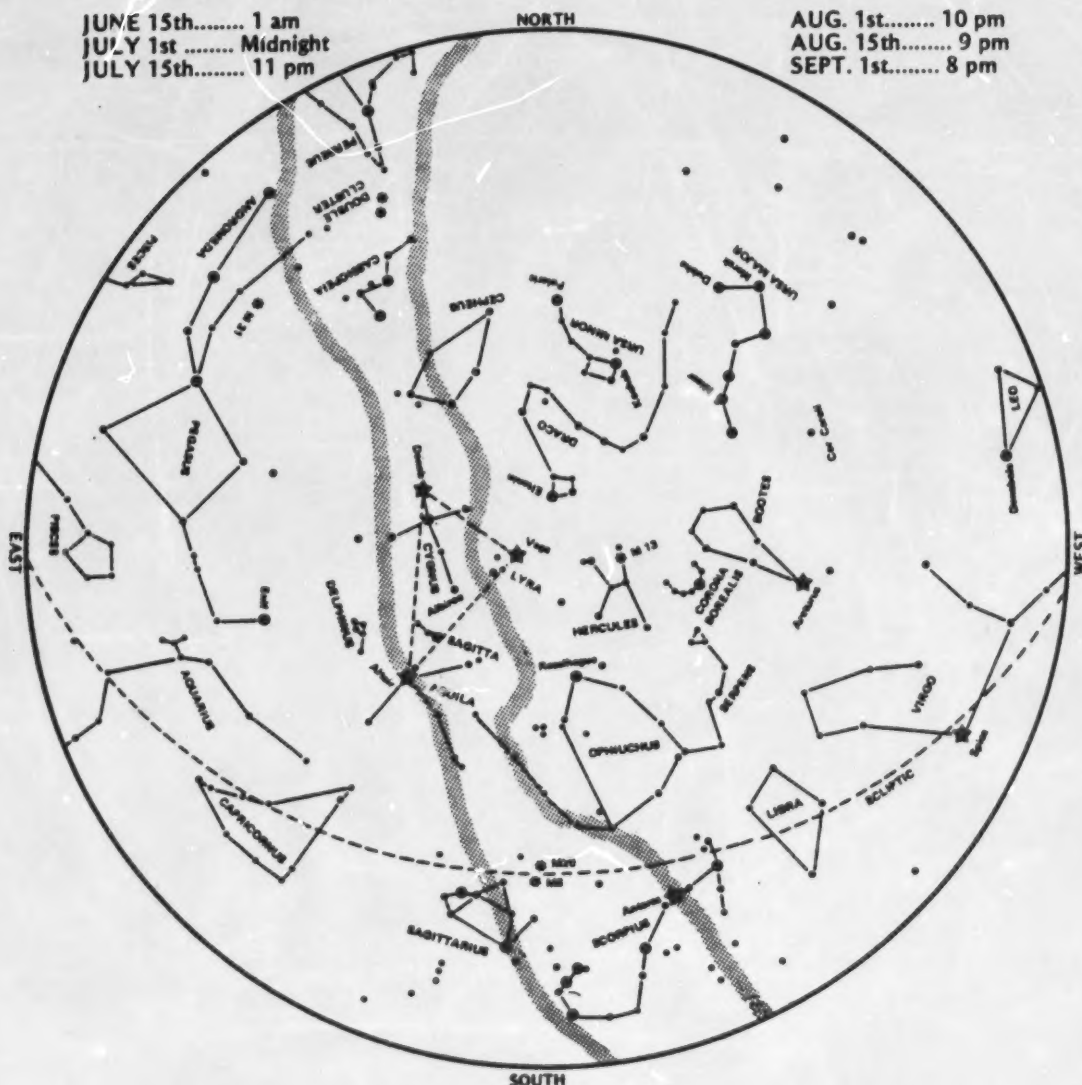
MANITOBA MUSEUM OF MAN AND NATURE • 190 RUPERT AVENUE • WINNIPEG, MANITOBA, CANADA R3B 0N2

SUMMER STARS

This star map will work best at these times:

JUNE 15th..... 1 am
JULY 1st Midnight
JULY 15th..... 11 pm

AUG. 1st..... 10 pm
AUG. 15th..... 9 pm
SEPT. 1st..... 8 pm



Hold the map overhead and turn it so that the directions marked around the map's horizons match the true directions. Try and find the brightest stars and constellations first, then the fainter ones. If any planets are visible they will look like bright stars. Planets are always found close to the ecliptic.

The objects marked like  M13 are objects such as galaxies, nebulae or star clusters. Under a dark country sky most of these can be observed with the eye alone. They are best observed with binoculars or a telescope.

For more information about sky watching, consult *The Sky Observers Guide* by Mayall, Mayall, and Wyckoff, The Golden Press, New York, 1965. A star map that will work all year, at any hour, is *Phillip's Planisphere*. These and other helpful publications are available at the Museum Bookstore.

MANITOBA PLANETARIUM

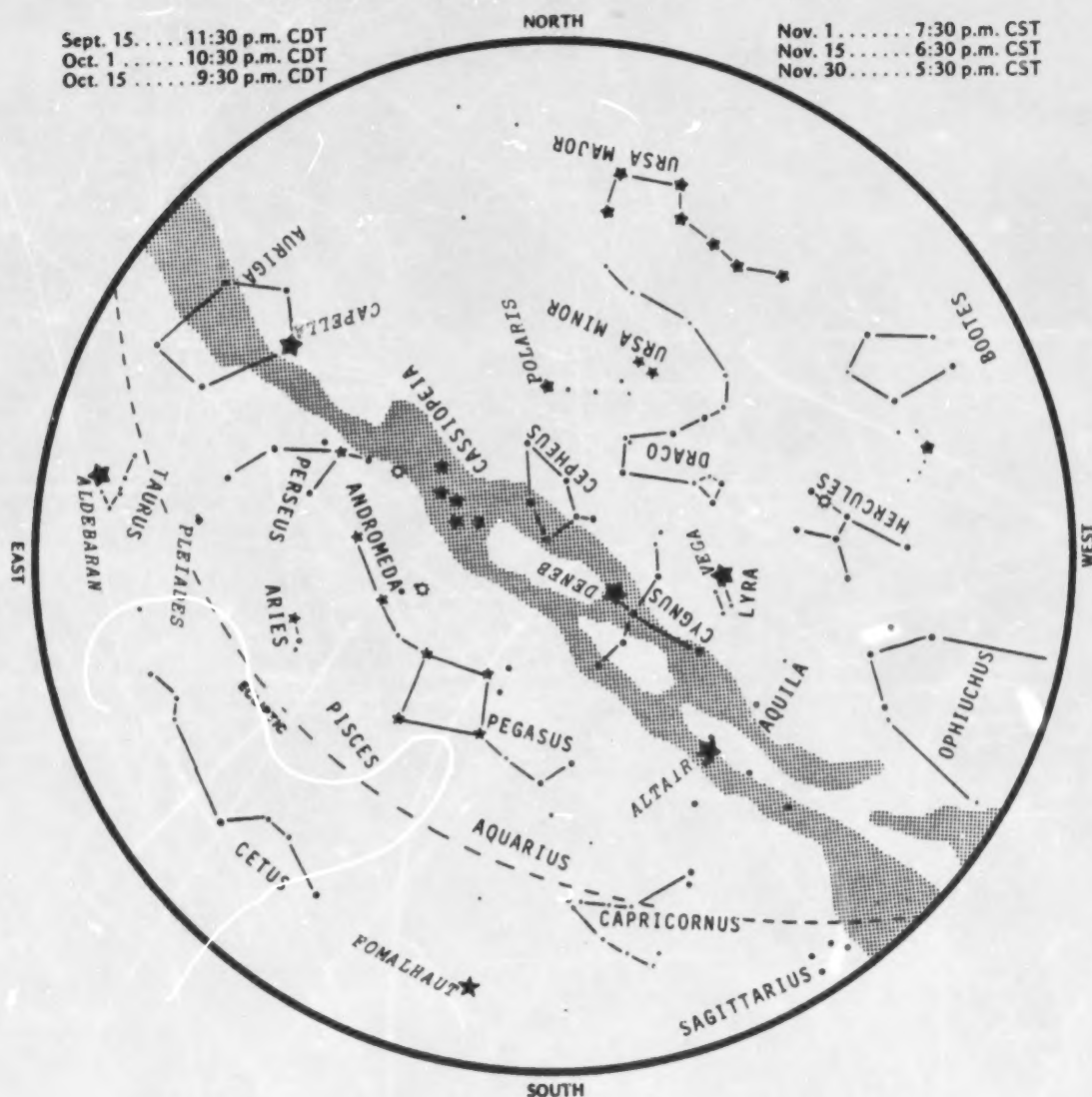
MANITOBA MUSEUM OF MAN AND NATURE • 190 RUPERT AVENUE • WINNIPEG, MANITOBA, CANADA R3B 0N2

AUTUMN STARS

THIS STAR MAP WILL WORK BEST AT THESE TIMES:

Sept. 15. 11:30 p.m. CDT
Oct. 1. 10:30 p.m. CDT
Oct. 15. 9:30 p.m. CDT

Nov. 1. 7:30 p.m. CST
Nov. 15. 6:30 p.m. CST
Nov. 30. 5:30 p.m. CST



Hold the map overhead and turn it so that the directions marked around the map's horizons match the true directions. Try and find the brightest stars and constellations first, then the fainter ones. If any planets are visible they will look like bright stars. Planets are always found close to the ecliptic.

The objects marked like ★ M13 are objects such as galaxies, nebulae or star clusters. Under a dark country sky most of these can be observed with the eye alone. They are best observed with binoculars or a telescope.

For more information about sky watching, consult *The Sky Observers Guide* by Mayall, Mayall, and Wyckoff, The Golden Press, New York, 1965. A star map that will work all year, at any hour, is *Phillip's Planisphere*. These and other helpful publications are available at the Museum Bookstore.

MANITOBA PLANETARIUM

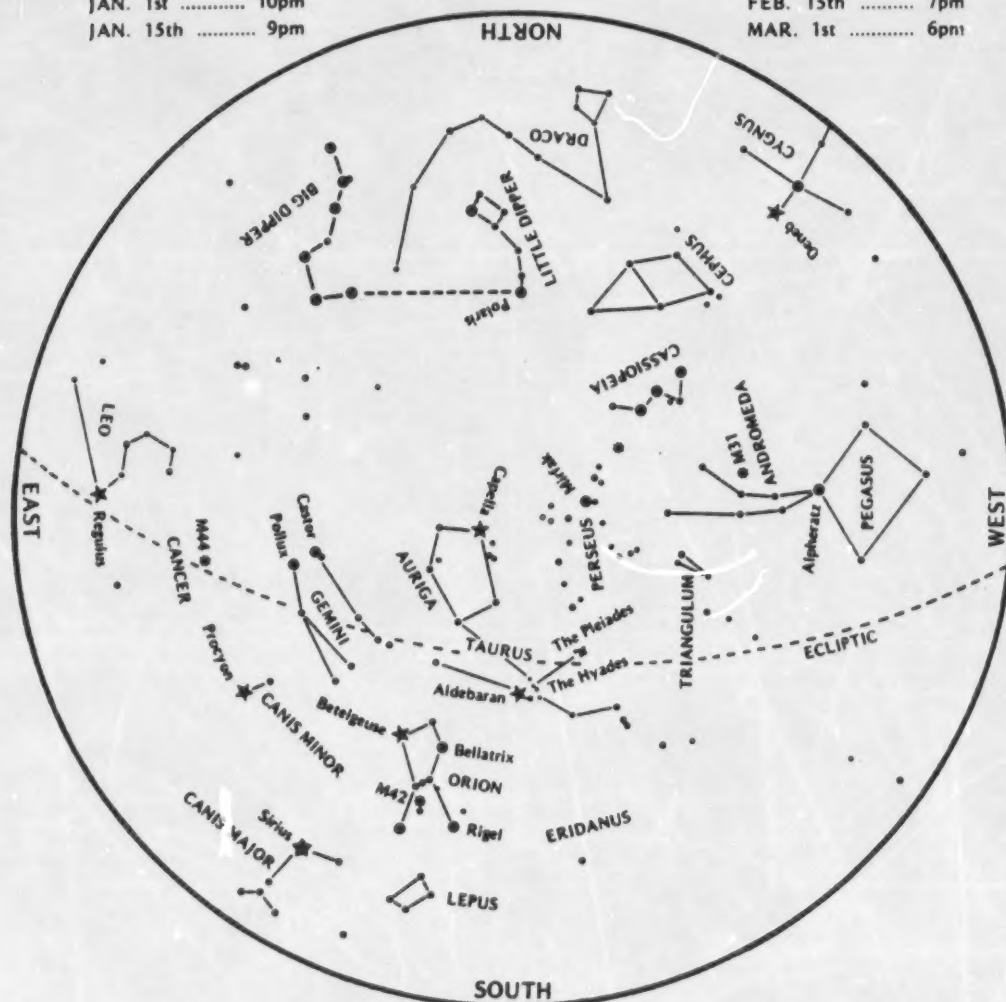
MANITOBA MUSEUM OF MAN AND NATURE • 190 RUPERT AVENUE • WINNIPEG, MANITOBA, CANADA R3B 0N2

WINTER STARS

THIS STAR MAP WILL WORK BEST AT THESE TIMES:

DEC. 15th 11pm
JAN. 1st 10pm
JAN. 15th 9pm

FEB. 1st 8pm
FEB. 15th 7pm
MAR. 1st 6pm



Hold the map overhead and turn it so that the directions marked around the map's horizons match the true directions. Try and find the brightest stars and constellations first, then the fainter ones. If any planets are visible they will look like bright stars. Planets are always found close to the ecliptic.

The objects marked like *M13 are objects such as galaxies, nebulae or star clusters. Under a dark country sky most of these can be observed with the eye alone. They are best observed with binoculars or a telescope.

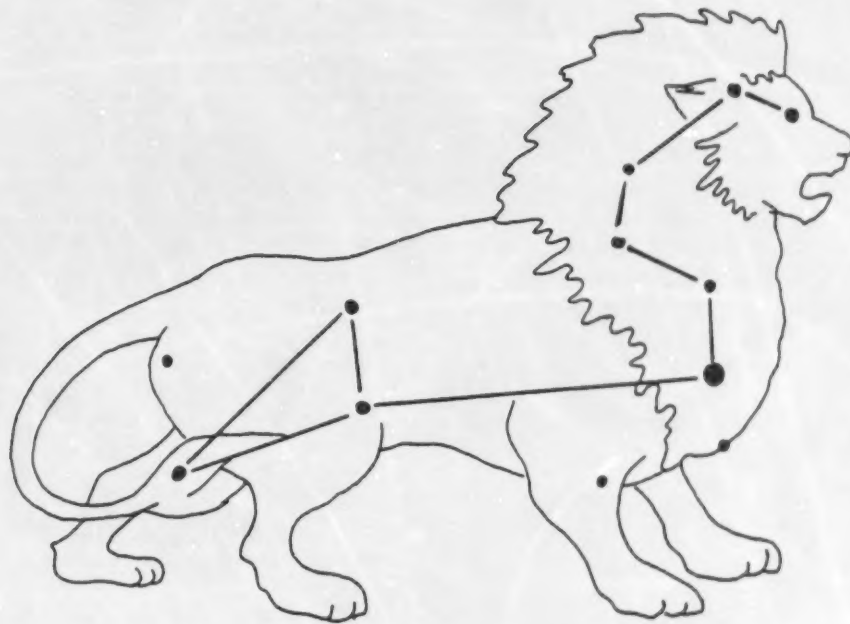
For more information about sky watching, consult *The Sky Observers Guide* by Mayall, Mayall, and Wyckoff, The Golden Press, New York, 1965. A star map that will work all year, at any hour, is *Philip's Planisphere*. These and other helpful publications are available at the Museum Bookstore.

MANITOBA PLANETARIUM

MANITOBA MUSEUM OF MAN AND NATURE • 190 RUPERT AVENUE • WINNIPEG, MANITOBA, CANADA R3B 0N2

CONSTELLATIONS

Leo, the Lion



**Canis Minor,
The Little Dog**



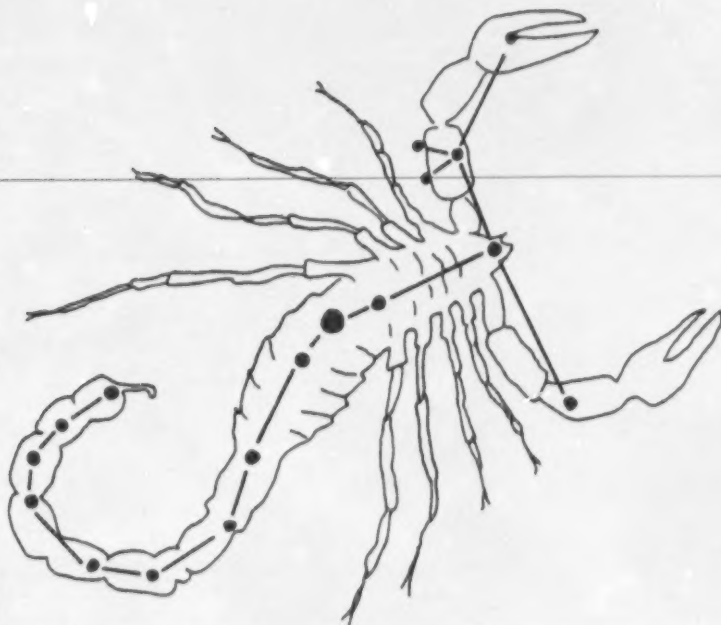
**Canis Major ,
The Big Dog**



Corona , the Northern Crown



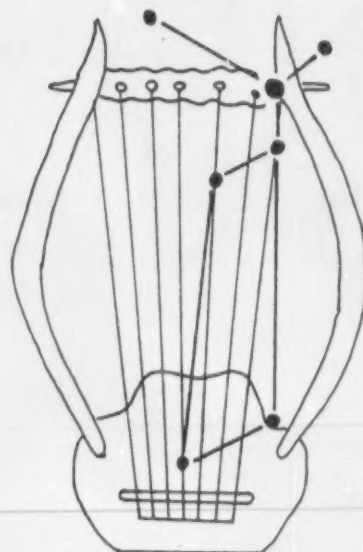
Scorpius, the Scorpion



Aquila, the Eagle



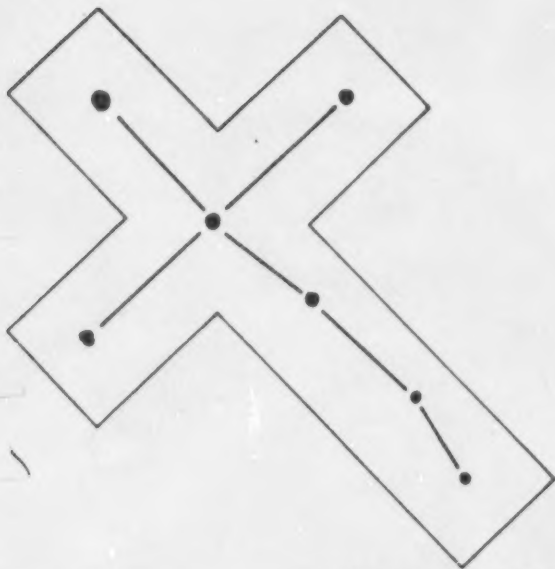
Lyra, the Lyre



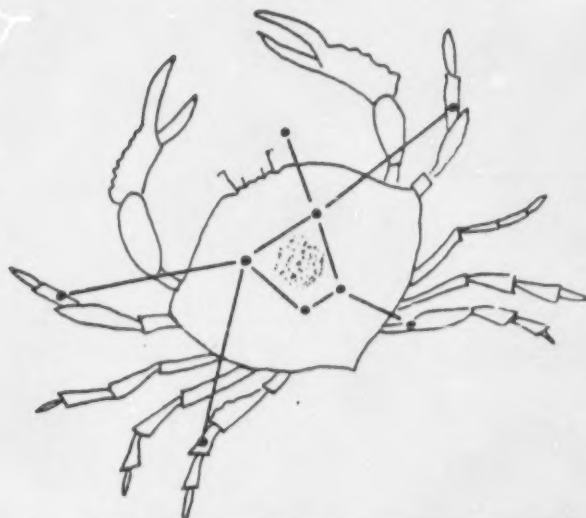
Virgo, the Maiden



The Northern Cross



Cancer, the Crab



Orion, the Hunter



Bootes, the Herdsman



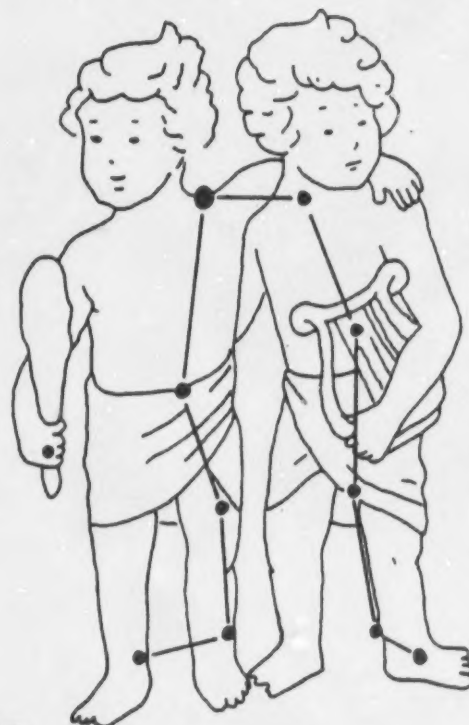
Hercules



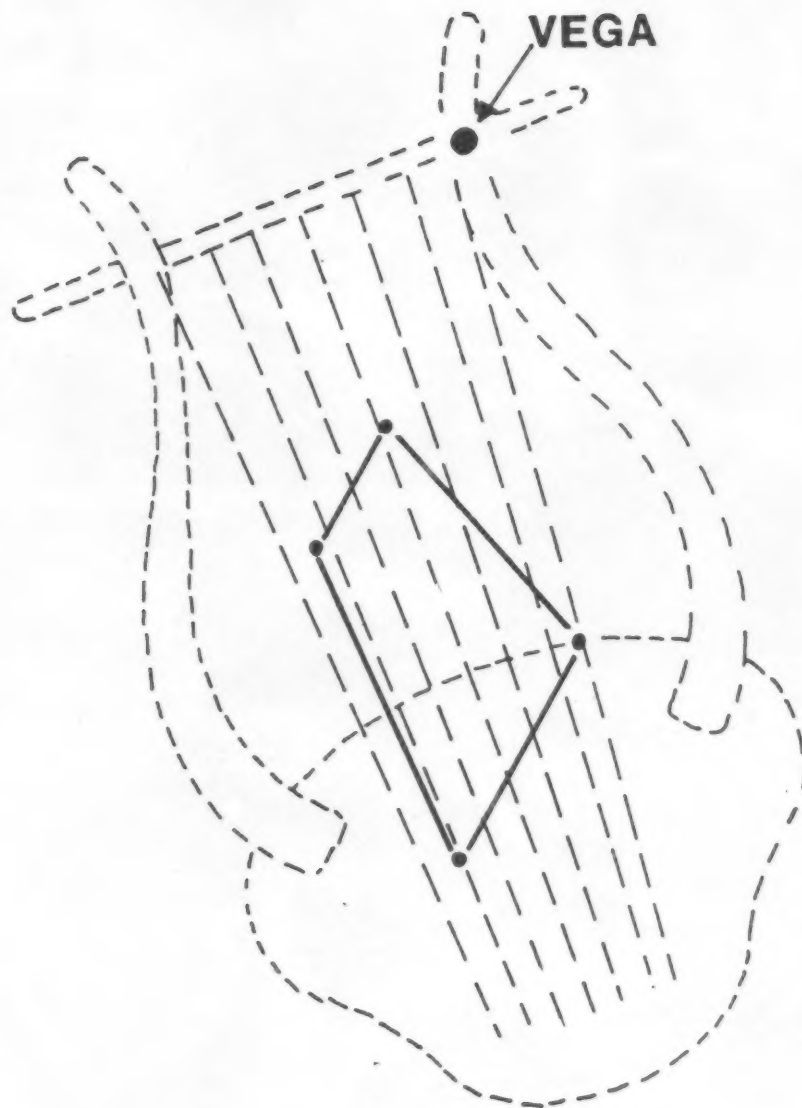
Cygnus, the Swan



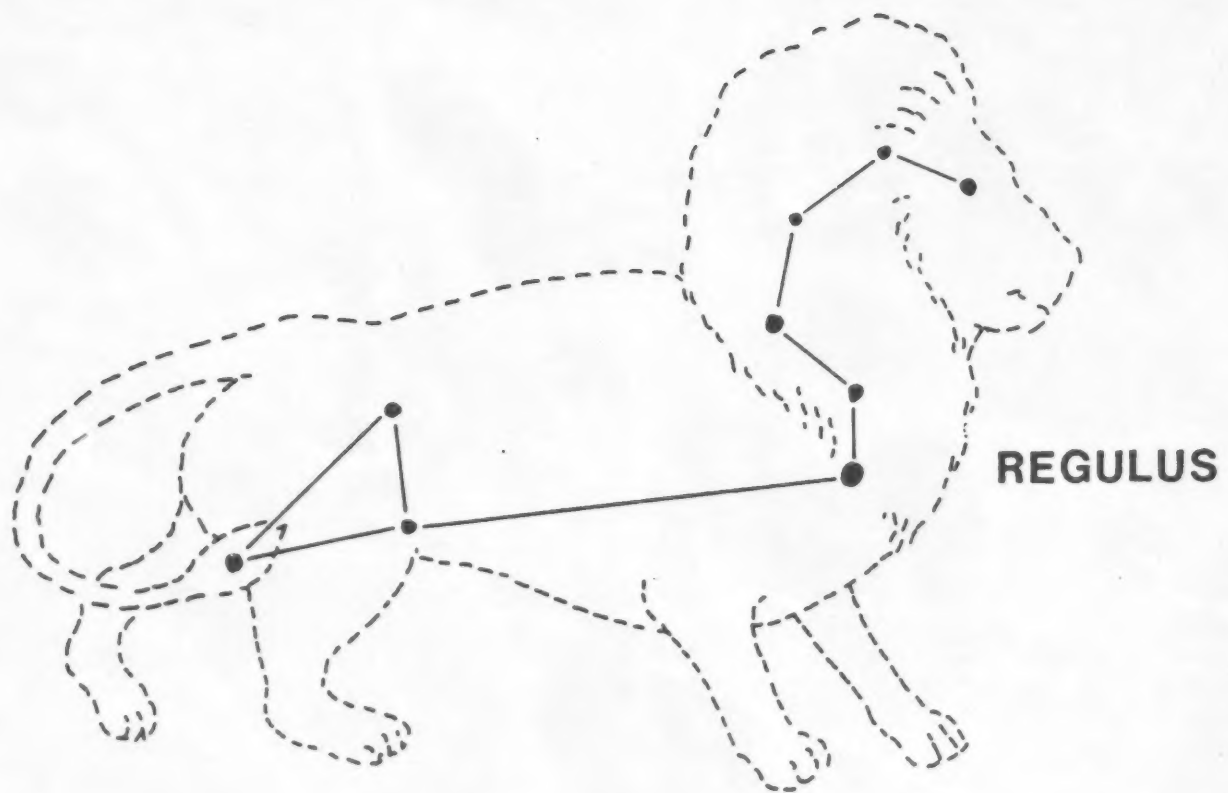
Gemini, the Twins



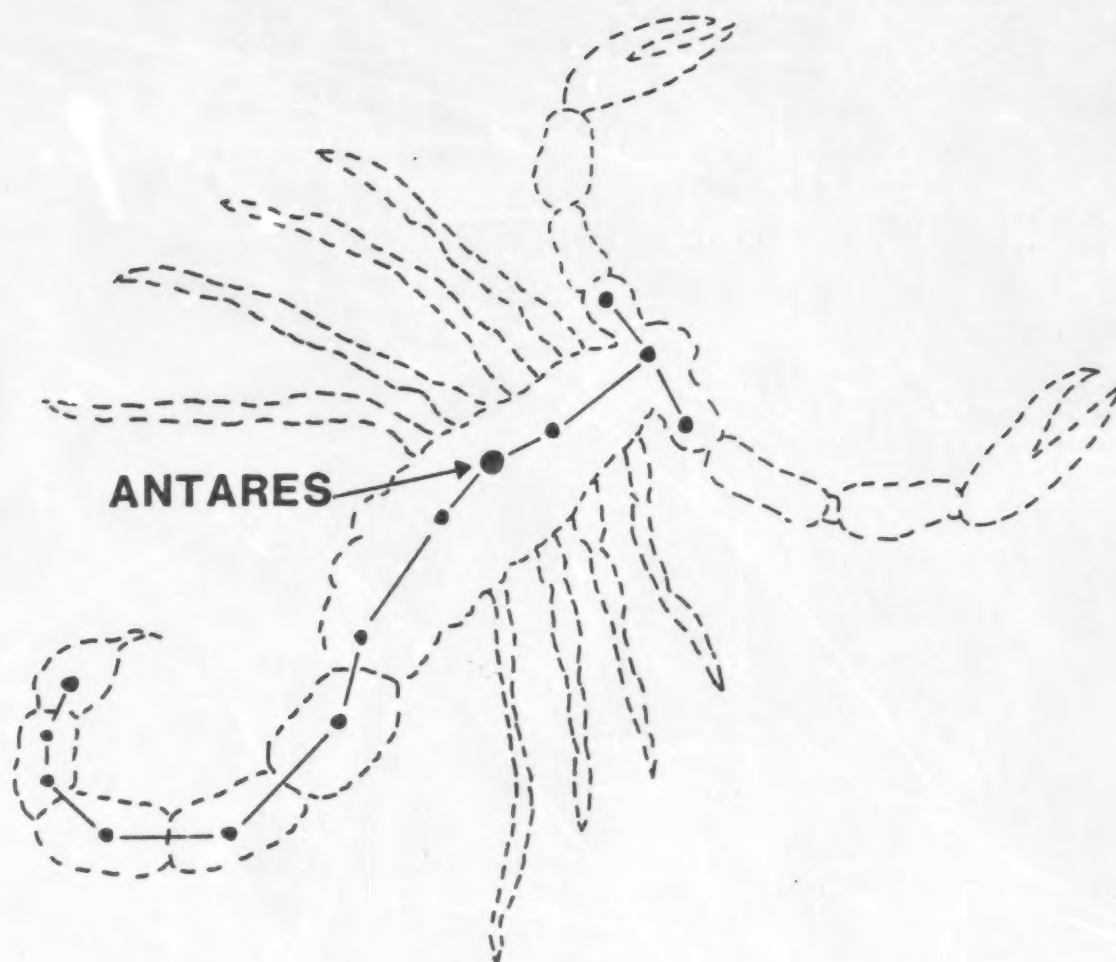
LYRA, THE LYRE



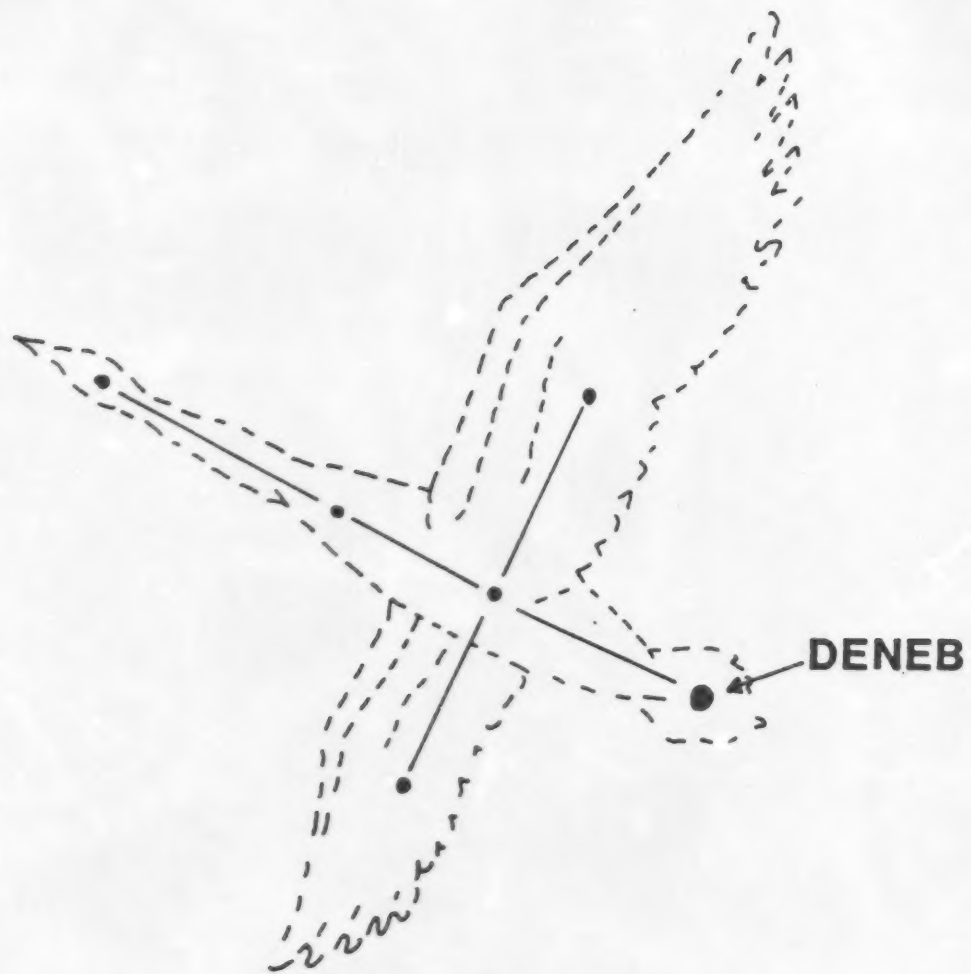
LEO, THE LION



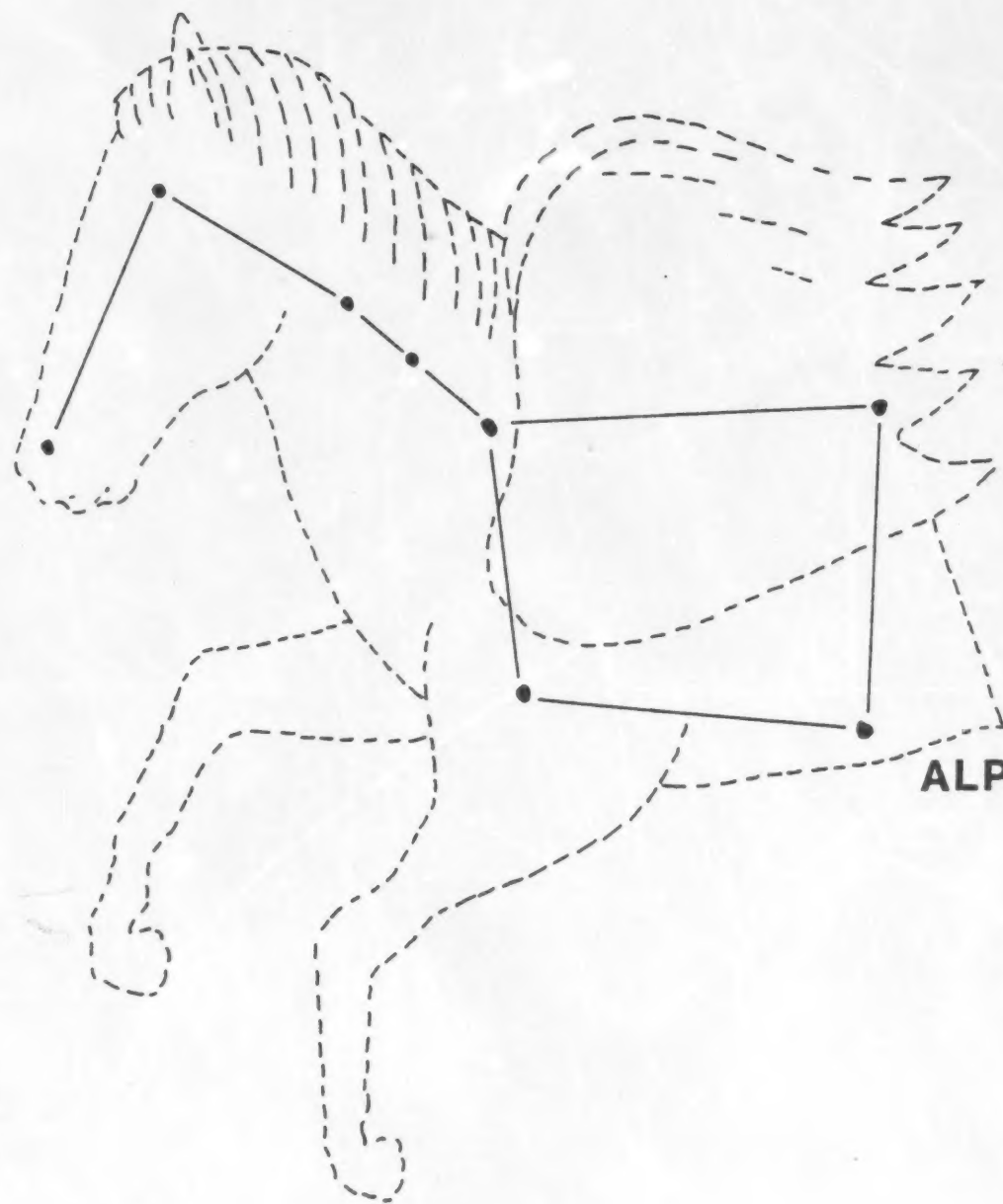
SCORPIUS, THE SCORPION



CYGNUS, THE SWAN



PEGASUS, THE WINGED HORSE



ALPHERATZ

AQUILA, THE EAGLE

